M. K. McCarty

PROCEEDINGS

Seventeenth Annual Meeting

NORTH CENTRAL WEED CONTROL CONFERENCE

DECEMBER
12, 13, 14, 1960

MILWAUKEE, WISCONSIN

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Proceedings
Seventeenth Annual Meeting
North Central Weed Control Conference

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ANNOUNCEMENT FOR 1961
THE NORTH CENTRAL WEED CONTROL CONFERFENCE
WILL SERVE AS HOST TO THE WEED SOCIETY OF AMERICA AT
ST. LOUIS, MISSOURI
DECEMBER 11, 12, 13, 14, 1961
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The 1962 meeting of The North Central Weed Control Conference will be held at St. Paul, Minnesota, December 3, 4, and 5.

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Preface

The Proceedings of the 17th Annual Meeting of the North Central Weed Control Conference presents a record of the papers and reports presented at the 1960 Conference in Milwaukee, Wisconsin, December 12, 13, and 14. With the exception of the President's address and certain invitation papers, only abstracts of the papers given, limited to 900 words, are presented here. Since essentially all of the papers are abstracts, none have been so marked.

The Research Reports have been printed and made a part of the Proceedings. In 1958 summaries of the Research Report and of the important advances in weed control from 1945 to 1958 were prepared by members of the Research Committee and published as "Research Summaries". This year, a second supplement to these reports has been prepared and is published as "Summary of New Research Findings", which follows immediately after the Research Reports.

Throughout this volume all rates of application of chemicals except inorganic soil sterilants are given in terms of the acid equivalent or active ingredient, so that no statement is made in connection with rates unless for some reason the rates cited are not of the acid equivalent or active ingredient.

Latin names of weeds and crops discussed and the full chemical names of herbicides for which standard names or abbreviations have been adopted by the Weed Society of America will be found in the indexes, and such names have been omitted elsewhere in the Proceedings. Chemical names of new chemicals are given in each report of their use, and also in the index. No new products of which the chemical identity has not been released are discussed in this publication.

Copies of this Proceedings are available at $4.00 per copy from John D. Furrer, Secretary-Treasurer, North Central Weed Control Conference, Department of Agronomy, 228 Keim Hall, University of Nebraska, Lincoln 3, Nebraska.

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SOME PROBLEMS IN USE OF HERBICIDES IN FORESTRY

Theodore T. Kozlowski[1] [2]

Introduction

It is well known that the magnificent forests which covered our country at the time of settlement grew without assistance from man. It is also known that forests are complex and dynamic ecosystems which protest against disturbance by their natural replacement through successional sequences to the original forest type. However, when forests are excessively cut, burned, or otherwise seriously disturbed we can hardly afford the time required for nature alone to produce forests of maximum usefulness. In fact, it may be desirable to maintain some of our commercial forests in an artificial condition and to favor transitory species of trees. There must always be concern with the rate at which forests produce valuable and specified crops. This is so because of the ever increasing demands for forest products and costs of holding land while forests grow. In short, forests must be skillfully managed for continuous production of usable products.

The large majority of the forests of the Lake States, with their great diversity of forest types, have been badly managed over the years (162). Prior to 1920 overcutting and subsequent fires caused rapid deterioration of vast forest acreages. These forests now show much lower productivity than they ought to primarily because of the presence of inferior species, wrong density of stocking, and trees of low quality. Out of 16 million acres classified as forest land in Wisconsin some 9 million acres are in critical need of better forest management. Fortunately the early abuses are now being remedied because of the sensitivity of federal, state, and private agencies to the urgency of the need. Eventually well-managed forests will be achieved through control of species composition; control of stand density; restocking of unproductive areas; protection from disease, insects, and fire; timber salvage; control of rotation; and site protection.

Basically the restoration of these forests will justify a number of diverse techniques, all with the central objective of providing maximum return from forest land in a given time. Reasonable specifications are implied. An important immediate objective for one site may be complete elimination of an inferior species; on another, prevention of resprouting. In still another area it may be important to kill tops of a tree species while in the same operation guaranteeing prolific resprouting to provide more accessible deer browse (93), or otherwise improve food habitats for wildlife (57). Another objective may be elimination of alternate hosts of tree disease fungi (1). On still other sites it may be desirable to eliminate or to suppress all competing hardwoods in order to release conifers which are already established but without much chance for rapid growth. In yet another area it may be necessary to kill out weeds to prepare a site for tree planting. It cannot be emphasized too strongly that in the future chemical herbicides undoubtedly will play a key role in the achievement of every one of these objectives.

The introduction of chemical herbicides rendered possible for the first time a really intensive, economically-feasible control of forest lands. Because of their effectiveness coupled with their low costs and speed and ease of application (147), herbicides save time and manpower to such a degree that in the future they will be considered indispensable for management of large forest areas. More specifically, chemical herbicides have a very bright future indeed in stand regeneration, release of conifers and crop trees, brush control, stand improvement following harvest cuts, plantation establishment, production of nursery stock, chemical debarking, fire lane and utility lane maintenance, roadside maintenance, control of tree diseases, and many other uses. We are only beginning to appreciate the vast potential of chemical control over forests. However, we would only be deluding ourselves if we denied categorically that there are dangers in using herbicides. As we have not fully realized the values of herbicides in forestry so we have not really begun to identify, characterize and control some of the deleterious herbicidal influences. Obviously much research is necessary in this challenging field. Skillful and efficient use of herbicides in forestry must involve not only an appreciation of forest biology, including hereditary and physiological characteristics of species involved, but also a knowledge of specific responses to herbicides of both plants to be fostered and those to be eliminated.

Control of Species Composition

Possibly the most challenging and promising area of use of herbicides in forestry is in control of species composition and tree quality over large acreages of forest land. Trees in dense stands compete for light above ground and for water, minerals and oxygen below ground. They also compete with non-woody vegetation. Young, natural forest stands and plantations with one to several thousand trees per acre may be reduced by competition to less than a hundred trees when mature. Low value hardwoods and brush often are deterrents to satisfactory establishment and growth of more desirable crop trees. The light requirements of competing hardwoods are much lower for maximum physiological activity than are those of conifers. Hence, growth of conifers is inhibited, or more often, conifers are eliminated by the more tolerant hardwoods. In the south, over a 20-year period, hardwoods replaced pine as a forest type on 13 million acres of land (61). For such reasons there must be concern with elimination of competing brush and undesirable hardwoods from stands designated to grow conifers. In addition, it is routinely necessary to eliminate individual cull conifer and broadleaf trees for stand improvement. In the past this was done by girdling trees but recently use of sodium arsenite in bored holes (33) or spaced axe cuts (30) has greatly decreased labor costs.

Conifer release is most commonly accomplished by foliar sprays with aircraft or helicopters over large areas or with ground equipment over smaller areas (8, 127). Overtopping hardwoods may also be eliminated by cut-bark frill treatments (7). This method provides for great selectivity in trees to be eliminated while aerial applications are cheaper and more easily made over extensive areas. Basal sprays can also be used to control hardwoods but large volumes of herbicides are required and, except in special cases, their general use on large trees is not recommended (10). The release of Christmas tree plantations is considered a special situation because even a small amount of damage cannot be tolerated. Arend and Roe (9) recommend actually cutting the undesirable hardwoods which compete with Christmas trees and spraying the stumps with 2,4,5-T in oil. Foliar sprays must be used with extreme caution on Christmas trees.

A good example of conifer release was reported by McConkey (109) in Maine. Following the extensive fires which burned over some 130,000 acres of forest land in southwestern Maine 1947 reproduction came back as a mixture of white pine and hardwoods. In 1954, two areas, 15 and 30 acres in size, were were selected on the Massabesic Forest for experimental conifer release. The exceedingly vigorous hardwoods, which were generally 5 to 10 ft. tall, were estimated to have up to 45,000 stems/A. These included white oak, northern red oak, black oak, red maple, white birch, gray birch, aspen, and pin cherry. White pine reproduction, generally less than 2 ft. tall, was well distributed throughout. Obviously the pine was experiencing great difficulty in this dynamic struggle for existence. The areas were treated on July 14, 1954 in strips at 50 ft. intervals from a helicopter flying at 50 miles/hr. Two herbicide dosages were used: 1 lb acid equivalent of 2,4,5-T/A on the area and 3 lbs acid equivalent/A on another part. Although the low rate was somewhat ineffective, promising control of hardwoods was achieved with the 3 lb/A rate. (Table 1).

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Table 1. Effects on hardwoods of 3-pound/A application of 2,4,5-T in 1954. Observations were taken at end of 1955 growing season (From McConkey, 1958).

Degree of understory kill	Birch	White oak	Red oak	Red maple
	(378)*	(20)*	(100)*	(120)*
Killed; no new sprouts	70%	90%	37%	2%
Top killed; new sprouts	30%	5%	34%	5%
Crowns more than ¾ dead			16%	9%
Crowns ½ to ¾ dead			2%	3%
Crowns less than ½ dead			11%	81%

* Basis: Number of trees (birches) or sprout clumps (oak and red maple) examined. Sprout clumps consisted of 2 to 5 or more stems per clump, dating from 1948. The extent of kill was tallied as that of the greenest stem in the fall of 1955.

The entire operation cost $14.05/A for the 3 lb application and $10.60 for the 1 lb application. McConkey (109) pointed out that $3 to $4 of this was chargeable to inexperience. He reported that in 1956 costs of 3 lb applications were reduced to $10.80/A. Arend and Roe (9) reported even lower costs. They estimated costs of conifer release to range from $4 to $7/A with fixed-wing aircraft and $7 to $15/A with helicopters. The tremendous advantage of chemical control of stand composition is appreciated when it is realized that elimination of overtopping hardwood competition with manpower would require as many as 4 treatments over a 10-year period. This probably would amount to several man days/A.

Hansen and Johnson (59) used monuron successfully in establishing openings in a stand in which old-growth white pine was scattered rather uniformly as an overstory to mature aspen, paper birch, and a few balsam fir. The moderately dense understory consisted primarily of hazel nut and a small number of viburnums, dogwoods, mountain maple, and other species. Opening the stand greatly stimulated the initial establishment of white pine regeneration.

In releasing conifers a complete kill of all competing hardwoods often is not necessary or even advisable from a site protection standpoint. The problem often is basically one of temporarily eliminating hardwood competition to provide the conifers with sufficient advantage to overtop the hardwoods. In fact, with white pine it may be essential to have a hardwood overstory during juvenile growth to avoid tip weevil attack. These hardwoods are later eliminated.

Selectivity of herbicides used in conifer release depends primarily on the physiological state of the conifers. If conifers are still growing actively they may be injured or killed even by light applications. Therefore, application should be delayed until new growth has hardened off. Of course, there are differences in sensitivity among Lake States conifers with jack and Scotch pines most susceptible to injury. Foliage sprays of 1 and 2 lb acid equivalent of 2,4-D and 2,4,5-T at 2.5 and 5 gals/A caused injury to new growth of white spruce until July 15; to red pine, white pine and Norway spruce until August 1; and to jack and Scotch pines until August 15 (9). In Manitoba, Waldron (154) found that applications of 2,4-D and 2,4,5-T at varying concentrations as late as the first week of August injured young white spruce trees. Thus one of the difficulties in effective use of selective herbicides often involves inherent differences in lengths of growing seasons of tree species. During the same year some species grow twice as long as others (79, 80, 81, 89). Forest stands become stratified into various crown classes which vary in lengths of growing season. Furthermore, the length of the growing season for a species varies with density of stocking (86). In addition, the length of the growing season for a particular species varies somewhat from year to year. Hence, there is some danger in establishing arbitrary dates for herbicide applications to release conifers. Some conifers such as red pine may respond to unusually favorable environmental conditions by late-summer bursting of current year buds (108), thus rendering them susceptible to herbicide injury. Growth is physiologically ordered in individual trees and, because of the tremendous amount of competition in forest stands, some trees go into dormancy while others are actively growing. Actually many factors influence the lengths of growing seasons of trees. Among the most important of these are species (90, 80, 92); age (150, 157); tree vigor (112); morphological characteristics (161); seed source (153, 14); temperature (62, 63); current-year or prior-year soil moisture conditions (72, 79, 80, 92); light intensity (51, 78); photoperiod (42, 157); soil physical properties (25, 169); and topography (44). Since growth is controlled by an ecological nexus the proper timing of herbicide application should consider more than some arbitrary date established in one experiment.

Root grafting. When individual trees are selected for removal as a means of controlling species composition great care must be taken to avoid killing of valuable adjacent crop trees by translocation of herbicides through root grafts. Natural root grafting of forest trees is exceedingly common (101, 102, 171, 95, 98, 16, 82, 83). Graham (53) reported from the literature that 19 genera and 56 species of forest trees have been reported to root graft. The most common type of graft is a self-graft between roots of an individual tree. Intraspecific grafts are exceedingly common while interspecific grafts are uncommon. Although grafting of the larger roots is most common, roots as small as ⅛ inch in diameter were found to graft in northern Wisconsin (82, 83). There apparently is considerable translocation through root grafts from one tree to another. Bormann (16) demonstrated movement of water, minerals, foods, dyes and poisons up to a distance of 53 feet between trees through root grafts. It also is well known that incitants of diseases such as oak wilt are spread through root grafts (98). According to Garner (50) a group of trees may be connected so effectively through root grafts that if all but one tree are cut, the root systems will survive on carbohydrates supplied by the remaining tree. A number of cases of "backflash" or translocation of poisons through root grafts to trees other than those treated have been reported (28, 16). In some cases it may be desirable to kill several trees by injecting only one. In other cases it may be crucial to sound forest management to kill only the injected trees. Much more research is needed in evaluating the role of root grafting in translocation of herbicides.

On some sites there is an intriguing possibility of controlling species composition with chemicals by taking advantage of variations in patterns of root growth. Growth of root systems of many trees is rather firmly fixed by their heredity (87, 91, 92, 132). Toumey (149) concluded that most forest tree seedlings can be classified into those with taproots which penetrate deeply and those with shallow roots and extensive laterals. In some areas taproots of oaks and hickories, which extend below the horizon of intense root competition, enable them to survive droughts better than do shallow-rooted species in the same stands (24, 78). In the west conifers such as western hemlock and western cedar have much shallower roots than western white pine, western larch, Douglas-fir and lowland fir (54). Lodgepole pine develops shallower root systems than western yellow pine. Because of natural stratification of roots of some competing species it may be possible, in some areas at least, to use soil surface sprays to eliminate the distinctly shallow-rooted species where this is desirable. At least this is a research area which, despite the obvious dangers involved, deserves much more attention than it has received.

Chemical control of forest composition is an established fact in principle but much research needs to be done. Virtually nothing is known about differential responses of conifer ecotypes to herbicides. In addition, work is needed on effects of herbicides on conifers of varying age and on different sites. Many experiments have dealt with gross observations, such as injury, and work is needed on effects of herbicides on basic physiological processes in trees such as photosynthesis, respiration and water relations. Relatively little has been done to test direct effects of herbicides on dry weight increase

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of conifers of varying vigor, crown class, and age. Much of the basic information about relative susceptibility of conifers to various herbicides may have to be obtained in controlled environmental facilities.

There is need for more research on the various combinations of environmental conditions which will result in best internal distribution of hormone-type herbicides. Experiments show that C^{14} applied as 2,4-D moves together with carbohydrates in phloem. Movement is toward physiologically active tissues (30, 32). No 2,4-D was translocated from young leaves which are importing food from more mature tissues (31). Since 2,4-D moves with the assimilate stream and not against it the tieup between photosynthesis and efficient hormone distribution is obvious (159, 168). However, refined and efficient techniques of application imply more than applying herbicides at time of maximum leaf development. Since photosynthesis varies seasonably and diurnally and is influenced by a host of environmental factors including light intensity, photoperiod, temperature, carbon dioxide, soil moisture, fertility, and diseases (92) much more can be done to develop efficient herbicides and identify the environmental conditions most conducive to their translocation.

In early, large scale aerial applications of 2,4-D and 2,4,5-T the problems of volatility and drift were serious. However, the introduction of low volatile esters in the last 10 years (3) and, more recently, of viscous invert emulsions has overcome the most serious aspects of these problems. Invert emulsions, when applied through centrifugal sprayers on fixed-wing or helicopter aircraft, represent a significant advance in chemical control of species composition in forest stands (76, 34). However, Kirch (77) believes that the superior translocation of invert emulsions which has been observed in the greenhouse has not yet been duplicated in the field.

Although there is much to be learned about control of species composition the startling results already achieved emphasize that use of selective herbicides will radically alter forest management practices, if it hasn't done so already. Proper use of herbicides promises to enable forest managers to grow desirable species of specified quality over vast acreages. It will permit a very intensive management of forests hitherto considered outside the realm of economic feasibility. Already reasonably satisfactory results are being realized at a much lower cost time and moneywise than is possible with hand labor. Forest managers are beginning to use foliage sprays extensively because even if a second application is necessary the whole operation is still less expensive than the equivalent result with hand labor (125).

The tendency toward intensive management of forest lands probably will involve more widespread applications of fertilizers by aircraft. Many studies have pointed up general infertility of forested areas characterized by deficiencies of all major, and some minor, elements (52, 146, 163). In the last decade a surge of interest in forest fertilization has developed in the U. S. (107, 163). There is no question that on many sites both vegetative growth (142, 103, 92) and seed production (2, 160, 92) can be increased in this way. This suggests the further prospect of combining fertilizer applications with herbicides in the same operation. Thus, at low cost, species composition may be controlled while growth of residual crop trees is stimulated. The combined effect of decreased competition and added fertilizer will accelerate growth of selected crop trees and hence provide much more efficient site utilization.

Sprouting. Sprouting is an exceedingly important type of forest reproduction. Although relatively unimportant in gymnosperms sprouting is most important in angiospermous trees. In Pennsylvania 75 percent of the oak forests are estimated to originate from sprouts and reproduction of oak-hickory forests of the Ozarks also is primarily of sprout origin (18, 104).

Thus, in certain stands a really effective elimination of undesirable hardwoods must be considered a two-phased operation involving killing of tops and preventing of resprouting. Walker and Wiant (155) reported top-kill and kill without sprouting for a variety of herbicides on several species of hardwoods. Many of the herbicides caused excellent kill of tops but few effected both good topkill and prevented resprouting.

The season of application of herbicides profoundly affects the amount of subsequent resprouting. There is considerable evidence that sprouting vigor is related to carbohydrate reserves. Seasonal fluctuations in stored starch and sugar appear to parallel sprouting vigor. In general sprouting is least abundant from stumps cut in early summer when trees have leafed out and have exhausted carbohydrate reserves, and it is greatest from stumps of trees which were cut during the dormant season. In Missouri, oak trees girdled in June had fewer trees sprouting, higher mortality of sprouts, fewer sprouts per tree, and smaller sprouts than trees girdled during other months (23). Similar sprouting patterns have been reported for aspen and cherry in northestern Wisconsin (143).

Since the problem of achieving killing of tops appears to be easier than that of preventing resprouting, more attention should be given to applying herbicides at the time of year when carbohydrate reserves are most nearly exhausted. Aspen trees that are sprayed immediately after full leaf development, when reserve carbohydrates have been exhausted by production of new tissues, seldom sprout. However, when sprayed at other seasons of the year aspen sprouts and suckers develop more readily (9). Control of aspen is particularly difficult because this species has a strong tendency to produce suckers from roots. Cut or girdled trees have produced sprouts and suckers for a distance of 100 ft. from the tree (5). Another difficulty is that some species which have pronounced sprouting ability, such as ash, sweetgum, oaks and hawthorn also are highly resistant to topkill (155). There are, of course, times when killing of tops with subsequent resprouting is desirable. For example, overbrowsing by deer causing depletion of their food supplies is a prevalent problem in some areas. Krefting *et al.* (93) had considerable success with herbicides in killing only tops of mountain maple *(Acer spicatum)* that had grown out of reach of deer in Minnesota. This operation deliberately stimulated regrowth to provide more deer browse.

Usually, however, the most serious problem involves prevention of sprouting. A way should be sought to stimulate dormant buds so they will become active and can be readily killed by herbicides. Considerable success has already been achieved in controlling sprouts (106). Bramble *et al.* (17), worked with scrub oak *(Quercus ilicifolia)*, a very difficult species to kill. They found that suppression of basal resprouting and apparent death of roots depended on complete wetting with 2,4,5-T solution of the root collar zone. Wetting the bases of stems without wetting the root collar killed the stems above the zone of application but was followed by vigorous sprouting from the root collar zone. When the root collar was thoroughly wetted the dormant buds were killed and resprouting was prevented. These results were substantiated by McQuilkin (111). Rushmore (129) controlled sprouting of beech by applying sodium arsenite in solution in holes bored in the stem about 3 ft. above the ground. For preventing sprouting of cut stumps Chaiken (22) recommended using ammonium sulfamate crystals in V-shaped stumps of small trees. For larger stumps it is more economical to spray the top and sides of stumps with 2,4,5-T in oil. Chaiken recommended 1 gal of 4 lb per gal commercial product to 20 gal of oil carrier.

In releasing conifers attention obviously must be given to applying herbicides at the time when conifers have hardened off sufficiently so they will not sustain injury. At the same time, some attention should be given to herbicide application at time of maximal leaf expansion of hardwoods and minimal carbohydrate reserve for control of sprouting. These two considerations often oppose each other because one calls for an early or midsummer application while the other may call for a late summer application. This merely points up some of the interesting problems involved.

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Brush Control

One of the really serious silvicultural problems of the Lake States is replacement by desirable species on land occupied by brush or low quality hardwoods (124, 125). Heavy cutting of Lake States forests opens stands sufficiently so invasion by brush species follows. In addition intensive fire protection has stimulated invasion of forest stands by brush species like hazel (172). According to Roe and Block (126) there are some 650,000 acres of plantable commercial forest land in the Lake States, and most of it is in the brush category. Planting such brush lands is expensive and additional subsequent expenditures are required. Roe (125) has emphasized the importance of converting low grade aspen stands to conifers. There are about 3 million acres of such stands in the Lake States. Neither hand cutting nor disking have been economically feasible in many areas. Roe believes that aerial spraying techniques need to be worked out to follow underplanting of these stands with red pine. According to Roe and Block (126) disking of brushy areas cost $15 to $20/A and could not be used in low land or rocky or steep slopes. They found that aerial spraying of brush consisting of hazel, willow, alder, mountain maple, and dogwood with a 50-50 mixture of 2,4-D and 2,4,5-T at a rate of 2 lb of acid in 4 gallons of water-oil emulsion/A killed brush tops so trees could be set in the middle of brush patches that otherwise could not have been planted. That the ground preparation cost only $6/A and the plantations could be brought through with no more than one subsequent release indicated that chemical brush removal will unquestionably be a tremendous silvicultural tool in solution of this problem.

Prevalence of bog species such as speckled alder and willows in formerly prouctive coniferous swamps constitutes a part of the same general silvicultural problem. Alder, which prevents regeneration of valuable trees, is estimated to occupy from 400,000 to 600,000 acres in the Lake States alone (145). Most areas occupied by alder can and should grow valuable species such as white cedar, white and black spruce, balsam, and others (38).

Swamp brush can be controlled with skillful employment of herbicides (11, 36, 37, 38, 154). Day (36) reported that alder, hazel and willow were sensitive to foliage sprays of 2,4-D and ammonium sulfamate applied in midseason. According to Stoeckeler and Heinselman (145) a partial elimination of alder, which was adequate for stimulating growth of young understory spruce or balsam fir, was obtained with foliar sprays of 2,4-D applied in midsummer at a cost of $5.78 to $6.98/A. Nearly complete elimination of alder was obtained with Ammate swabbed on freshly cut stumps at a total cost of $24.81/A. Results which were almost as good were obtained with 2,4,5-T applied as a foliar spray at a cost of $12.68/A. According to Zehngraff and von Bargen (172) 20,000 hazel stems/A could be eliminated for $6 to $7 by hand spraying. Day (38) believes that basal and stump sprays of 2,4,5-T or mixtures of 2,4,5-T and 2,4-D concentrations up to 10,000 ppm are more practicable than foliage sprays. Basal sprays have been variously applied but most commonly with ordinary knapsack sprayers. However, when stands are less than 6 ft. tall foliage spraying often is quite practicable.

In applying herbicides in frills of brush species considered difficult to eradicate the use of an oil carrier is advisable. Arend and Coulter (6) found that scrub white oak trees were readily killed by applications of an ester of 2,4,5-T ranging from 1 to 10 percent by volume in diesel oil when applied in frill girdles.

All trees had dead tops by the end of the first growing season following application regardless of the concentration of herbicide used and season of application. In contrast scrub white oak treated during the dormant season with the highest concentration of herbicide in water failed to show any effects of treatment two seasons later.

Despite the demonstrated potential of chemical brush control there is much to be learned in matching appropriate herbicide, dosage, as well as method and time of application to species or combination of species. There are wide variations in response of brush species to herbicides. Oaks aften are difficult to kill by foliar sprays because absorption is inhibited by a thick waxy cuticle. Brinkman (19) observed that white and post oak were easier to kill than black and scarlet oaks while black jack oak was most resistant. Some oaks are difficult to kill with any herbicide (20). Furthermore, oaks are prolific sprouters.

A formulation of hormone herbicide absorbed best by one species may be less effectively absorbed by another. Walker *et al.* (156) compared absorptions of three formulations of 2,4,5-T tagged with C^{14} as a spray on water oak (*Quercus nigra* L.) and sweetgum (*Liquidambar styraciflua* L.). For water oak triethylamine salt was highly superior, followed by acetone solution and ammonium salt. For sweetgum, acetone was most readily absorbed, followed by triethylamine and ammonium salts. Overcoming some of the difficulties in getting efficient hormone distribution in trees undoubtedly will require much greater research effort on basic physiological aspects involving cuticle penetration and herbicide translocation.

Plantation Establishment

Elimination of grasses and other herbaceous vegetation prior to planting often is essential for successful plantation establishment (58, 97). Weed competition during the first year after planting has been responsible for many failures of forest plantations. The problem is crucial in the Lake States where much planting is done on abandoned farms. Control of quackgrass (*Agropyron repens* (L.) Beauv.) is exceedingly important to increase survival of seedlings on open areas. The advantages of chemical over mechanical weed control prior to planting were recently summarized by Hovind (70). He pointed out that chemical scalping is less expensive than mechanical scalping, allows trees to get above competition in a shorter time, creates less disturbance and does not stimulate as much or as rapid regrowth of competing weeds. Furthermore chemical site preparation makes possible planting operations on wetter sites and steeper slopes without danger of erosion. It also gives planted trees the benefits of organic matter from the killed weeds (70). Mechanical site preparation has been found to increase planting costs by 20 to 90 percent (113). Furthermore, in some areas mechanical site preparation has not improved growth of forest trees (114).

The possibilities of advantageously using herbicides together with a tree planting operation were pointed up by Hovind (70). He applied herbicides in bands 2 ft. wide, spaced 6 ft. apart. A tractor pulling a planting machine furnished power for the spray pump and the whole job of spraying and planting was accomplished as a single operation. Tree survival was greatly increased in bands receiving the herbicides (Table 2). White (164) recently compared the use of fertilizers, planting techniques and weed control to overcome early checking of white, Norway and blue spruce plantations on a variety of planting sites in Michigan. Site preparations included plowing, rototilling and triazine herbicides. Control of weed competition was highly beneficial. Fertilization without weed control resulted in reduced effectiveness of soil amendments. Eight lb/A of 50 percent wettable simazine at time of planting was rated superior for survival and growth. No foliage injury was observed at this rate. Hansen *et al.* (60) reported definite residual control of quackgrass in new red pine plantations with triazine herbicides applied at 10 lb/A. The University of Wisconsin in cooperation with the Wisconsin Conservation Department has field experiments involving applications of a variety of herbicides together with the planting operation. More work needs to be done in this direction.

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Table 2. Effect of herbicides on establishment of red pine plantations in central Wisconsin. (From Hovind, 1959).

Treatment (lb/A)	Percent grass control		Percent tree survival		Tree condition	
	6/20/58	8/19/58	8/19/58	7/31/59	Initial growth	Thriftiness of living trees
Simazine, 3	55	75	75	42	Fair	Thrifty
Simazine, 1½	35	60	69	33	Fair	Moderately Unthrifty
Simazine, 1½ and dalapon, 7½	90	70	87	59	Good	Thrifty
Dalapon, 12	100	60	71	7	Fair	Unthrifty
Dalapon, 7½ and amitrol, 3	100	55	81	17	Good	Unthrifty
Amitrol, 4½	75	45	77	7	Fair	Moderately Unthrifty
Furrow only	90	60	87	18	Good	Moderately Unthrifty
Control			21		Poor	

Production of Nursery Stock

In 1959 forest nurseries of the Wisconsin Conservation Department alone distributed over 42 million trees for planting. Of this total about 40 million were conifers. The estimate for 1960 production was about 50 million trees. Some idea of the costs of hand weeding in forest nurseries may be gained from Table 3.

Table 3. Hand weeding costs in Wisconsin Forest nurseries*

Type of stock	Cost/acre	Cost/100 seedlings
1-0 seedlings	$1,380.16	$ .82
2-0 seedlings	953.40	.66
3-0 seedlings	708.24	.36
2-1 transplants	1,216.72	3.88
2-2 transplants	953.40	3.25

* Data supplied by W. H. Brener, Supervisor of Forest Nurseries, Wisconsin Conservation Department.

It is apparent that there is an abiding need for chemical weed control in forest nurseries and the future for herbicides in forest nurseries is indeed promising. For a number of years the use of mineral spirits or Stoddard solvent applied full strength at dosages up to 75 gallons/A cut costs of weed control in nurseries by 20 to 90 percent. However, refined petroleum products are far from ideal nursery herbicides. There is considerable variation in toxicity of mineral spirits to different species of conifers (123). Mineral spirits also are toxic to deciduous species. Stoeckeler (144) reported that first-year pine seedlings may respond by showing chlorosis or "oil burn" spots at the ground line. Leaf discoloration and seed injury have also been reported. Mortality commonly occurs in very young seedlings.

Some rather interesting and exciting results have been reported with other herbicides. Holm (66) reported on experiments with sesone, monuron, diuron, and dalapon. Taylorson and Holm (148) emphasized that mixtures of herbicides in transplant beds provided better weed control for longer periods of time and controlled more weed species than the component chemicals alone. The Wisconsin group will report on use of several other herbicides in forest nurseries at this conference.

A host of nursery herbicide problems require immediate investigation. As stressed by Holm (148) attention should be directed to control of established perennial weeds in transplant beds. Ideally nursery managers would like to use herbicides in seedbeds as pre-emergence sprays and apply them immediately after seeding. However, susceptibility of tree seedlings to herbicides varies greatly with age, with newly germinated seedlings most susceptible to injury. Thus many herbicides which can be used in transplant beds cannot be used successfully on seedling beds as pre-emergence sprays. Work by the Wisconsin group indicates that whereas some triazines when applied as sprays at rates up to 1 lb/A were exceedingly toxic to germinating red pine seedlings they were not harmful to seedlings a few months old (84, 94) (Table 4).

Table 4. Effect of time of simazine application and dosage on production of red pine seedlings. Seedlings were harvested 23 weeks after planting. (From Kozlowski and Kuntz, 1960).

Time of simazine application (wks after planting)	Seedlings per sq ft at harvest	Dry wt per sq ft at harvest (grams)	Dry wt per seedling at harvest (grams)
	One pound per acre		
8	112	20.21	0.1804
13	218	22.60	0.1029
17	321	30.01	0.0094
	One-half pound per acre		
8	231	24.53	0.1327
13	258	26.73	0.1034
17	272	24.55	0.0903
	Control-no herbicide		
	334	35.04	0.1050

Another serious problem is that of possible persistence of herbicides and accumulation of toxic residues in nurseries where beds are used repeatedly to grow a variety of tree species for different lengths of time. Longevity of different herbicides in soil varies greatly and is influenced by leaching, microbial action, adsorption, volatilization and chemical reaction (12, 39, 40, 74, 117, 135). The downward movement of herbicides depends on their solubility (115) and absorption to soil particles. According to Hill (64) diuron moves more slowly than monuron in soil because of the lower solubility of diuron. Adsorption of herbicides in soil is affected by a variety of factors including temperature, nature of solvent, pH, organic matter and soil texture (29, 35, 41, 45, 64, 68, 118, 133, 136, 141, 151, 152).

Herbicide movement in soils may be influenced by the amount, intensity and frequency of rainfall or irrigation. Movement of monuron from upper soil layers increased as the amount of simulated rainfall increased (151). On the other hand, when forest nursery soils to which simazine and atrazine were applied were leached with 2 surface inches of water, the herbicide remained in the upper soil levels. Other experiments indicated that simazine was not leached out with as much as 16 surface inches of water (75).

Obviously much additional research is needed on the fate of herbicides in soils. The leachability of various herbicides needs to be characterized for specific forest nursery soils. Although some bioassays (21, 68, 121) and physical and chemical assay methods (15, 49, 170) have been developed new methods are urgently needed for assaying herbicides and their products in forest soils. In addition, controlled environment experiments are needed to identify effects of atmospheric factors on breakdown and movement of herbicides. Such basic information appears critical for safe use of herbicides in the field.

The importance of mycorrhizae in forest nursery soils is well recognized. Persidsky and Wilde (119) reported an increase of several hundred percent in growth of tree seedlings in soil inoculated with mycorrhizal fungi over uninoculated soil. Any chemical treatment which interferes with mycorrhizal development necessarily poses a serious problem. Persidsky and Wilde (119) reported treating forest soil harboring mycorrhizal fungi with a combination of chlordane, thiosan and allyl alcohol and then using this soil for inoculation of mycorrhiza-free prairie soils seeded to Monterey pine. Subsequent growth of the tree seedlings indicated that the biocides virtually eliminated the mycorrhiza-forming organisms. Under a light application of chemical some of the fungi survived but their growth-pro-

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moting efficiency was decreased by about half. These experiments point up the need for developing a different concept of herbicidal selectivity—one which will provide for tolerance of both trees and mycorrhizae to the herbicide while still eliminating weeds. This is obviously an area for much additional research.

It is becoming increasingly apparent that different species and varieties of nursery stock vary greatly in their tolerances to various herbicides. On light sandy soils the safety margin between dosages which gave adequate weed control and those which cause injury to various species often is small. This needs to be clarified. Studies are also needed on anatomical responses to herbicides. There are a number of reports of leaf curling, arrested development, and other undesirable responses to herbicides. Shuie and Hansen (137) reported pronounced effects of 3-amino-1,2,4-triazole on anatomical development of red pine and white spruce needles.

The pointing up of serious problem areas in forest nurseries should stimulate urgently needed research. Variations in structures and activities of different herbicides provide tremendous potential for use of herbicides in forest nurseries, provided we learn more about the specific effects of different herbicides on nursery stock.

Chemical Debarking

Another promising area for herbicides in forestry is that of chemical debarking (165, 167, 48). Truly startling possibilities have been demonstrated in chemical treatment of standing trees to loosen bark in the field. According to Cook (26) chemical peeling can provide inexpensive, efficient and easy removal of bark from most speices of northern hardwoods except ash and the birches. Thus savings can be realized by transport of drier and lighter wood (56, 110, 116). Chemical debarking also decreases possibilities of decay and insect attack in storage areas (27). Fawcett and Cochran (46) found chemical peeling useful for treatment of tree diseases and Hosner and Minckler (69) emphasized its usefulness as an economic and practical way of utilizing plantation thinnings.

Many chemicals, including various formulations of 2,4-D; 2,4,5-T, and their mixtures; ammonium sulfamate; sodium arsenite; ammonium fluoride; copper chloride and a host of others have been used in chemical debarking by a number of investigators. Most research to date points up that the best effects are obtained with chemicals that have a quick toxic action (55). All arsenic compounds are highly effective provided they are not diluted below 10 percent concentration of arsenic (167). Sodium arsenite has been used with most success.

The efficiency of chemical treatment varies greatly with species (13, 166). Holmes (67) observed that oak and chestnut peeled easily; ash and sycamore maple badly; and beech, birch and elm were intermediate in that bark removal was easily accomplished over the lower two-thirds of the stem but remained tight at the top. Some idea of species variations in peeling ability may be gained from Tables 5 and 6. Although efficiency of chemical treatment varies greatly with season of application, white pine has been successfully treated for chemical bark peeling by using sodium arsenite as late as September 24 (131). Fast growing, dominant trees with very active cambial zones have a longer peeling season than intermediate or suppressed trees. Vigorous trees have a wide zone of thin-walled cambial derivatives. They are affected more completely by chemicals because the basis of chemical debarking involves killing of tissues while they are still thin-walled. After treatment there is extensive collapse of cambial cells and their derivatives. Partially collapsed vessels and differentiating phloem cells often are seen after treatment. In short, the mechanism involves killing of thin-walled elements inside the cambium. This is followed by collapse of these cells causing spaces to form between the bark and wood. Freezing and thawing during the winter further separate bark from wood (167). Among other factors which influence chemical peeling are geographic location, diameter. season of year composition of the treating chemical, temperature, available moisture, effect of wetting agents, and time of standing after treatment before felling and peeling (71, 73).

Table 5. Peeling class of arsenic-treated trees by treating season. (From Wilcox *et al.*, 1956).[1]

	Pre-sap peeling	In sap-peeling season			Post-sap peeling	Mean
		Early	Mid	Late		
Conifers	74.9	43.5	49.5	52.8	57.3	54.1
Hardwoods	74.1	55.2	51.1	53.7	74.2	55.2
All species	74.7	52.0	51.1	53.4	66.1	54.8

[1]The data are based on a resistance to peeling scale based on the following: 0-Bark off on the standing tree; 1-Bark falls off in felling the tree; 2-Bark comes off in skidding the tree; 3-Bark comes free without pressure when using peeling spud; 4-Better than sap-peeling; 5-Average sap peeling condition; 6-Harder than sap peeling; 7-Difficult to peel; 8-Bark must be scraped from wood; 9-Will not peel. The values in the table are computed on average of the peeling figure for all bolts of tree multiplied by ten.

Table 6. Peeling classes of different species. (From Wilcox *et al.*, 1956.) Four-year averages for treatment with sodium arsenite at mid-peeling season.

Species	Peeling class	No. of trees
Red oak	30.8	6
American elm	34.5	10
Hemlock	34.9	230
Aspen (trembling & bigtooth)	37.9	196
Tulip poplar	38.0	10
Beech	41.6	136
Red spruce	48.0	213
Hard maple	50.6	214
Yellow birch	51.8	231
Red maple	52.2	273
Balsam fir	58.0	303
White birch	70.2	212
Ash	75.1	44

The ordinary techinque of application involves mechanical removal of a band of bark around the tree and brushing the chemical in solution, usually sodium arsenite, on the sapwood. The tree is left standing and peeled later, usually the following spring. According to Rushmore (128) application of sodium arsenite to frills also works well.

Since arsenic compounds have in general given the best results questions have been raised about possible dangers to humans and wildlife. The poison presumably is available through spilling or dripping as well as on the face of the treated tree. However, most of the sodium arsenite is rapidly absorbed into the exposed wood and translocated upward. Its distribution through the tree volume serves to dilute it (167). Arsenic analyses on trees chemically debarked with sodium arsenite, on pulp made from these trees, and on pulp to which arsenite was added at the start of the pulping process, showed that arsenic content was well below the concentration allowable in food (140). In one study spent liquors were found to have 0.0097 percent arsenic. However, this had no effect on the pulping process or on mechanical strength of the pulp. No arsenic could be detected in the dried pulp (120).

Experiments by Webb *et al.* (158) in New York State emphasized that chemical debarking was not a serious threat to animals. Populations of small mammals including red squirrels, chipmunks, and mice were not affected. Nor was there any conclusive evidence that chemical debarking was a serious threat to deer (Table 7). Furthermore, what hazard there was could be reduced by adding repellents to the chemical.

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Table 7. Animals found dead on chemical debarking areas and acres involved. Data for Maine, New Hampshire, Vermont, New York and Michigan. (From Webb, *et al.*, 1956.)

	1951 and 1952	1953	1954
Estimated area treated—acres	8,800	13,200	9,700
Deer found dead	14	11	0
Deer containing arsenic	2	5	0
Small animals found dead	6	15	1
Small animals containing arsenic	4	12	1

Although sodium arsenite has shown excellent results in debarking some other chemicals have shown variable promise. Working with 2,4-D, 2,4,5-T and ammonium sulfamate Arend (4) concluded that, with the exception of red maple, debarking of hardwoods was unsatisfactory. On the other hand Lohrey (105) found that non-toxic alkanomine salts of 2,4-D and butoxy ethanol ester of 2,4,5-T could be used to loosen bark on bigtooth aspen but not on red oak. The specific formulation of phenoxy herbicides apparently influences herbicidal efficiency. Raphael (122) used the propylene glycol butyl ester of 2,4,5-T on trembling aspen bark and concluded that it was ineffective in promoting bark removal. However, Shiue *et al.* (138) found that trembling aspen sprayed with the butoxy ethyl ester of 2,4,5-T peeled readily even when the trees were cut in the dormant season. In another experiment Shiue *et al.* (139) observed that effective absorption of 2,4,5-T through the bark of aspen was dependent on a bark extractive, presumably a saponin. This promising lead opens up a whole research avenue that may provide new chemicals which will be effectively absorbed through the bark and stimulate its separation from the wood.

Firelanes and Pulpwood Storage Yards

A serious fire hazard is created in firelanes and pulpwood yards. This danger is especially critical before the period of new growth in early spring and the dry period of late summer and early autumn. Pulpwood yards often have an abundance of dry wood waste which intensifies the hazard. Furthermore, such yards often are located close to water so high water tables in the yards are conducive to rapid weed growth. Considerable success has been reported in controlling weeds in firelanes and pulpwood areas for as long as 5 years (47, 99, 100). Hence, it appears that fire prevention with herbicides is an excellent investment.

Control of Tree Diseases

Infectious tree diseases are controlled primarily by preventing spread of inciting agents or initial host infection. Thus herbicides are useful in eradication of *Ribes* to prevent spread of white pine blister rust. Eradication of sweetfern with herbicides is useful in control of burn blight of young jack pine and red pine trees (96). As emphasized by Drake and Kuntz (43) spread of incitants of other diseases such as oak wilt through root grafts can also be prevented by isolating wilt-infected pockets by poisoning surrounding healthy oaks.

Summary

Increased demands for wood will necessitate that forests be more skillfully managed in the future for continuous production of usable products. Forests which have been badly managed can be improved by attention to control of species composition; control of stand density; restocking of unproductive areas; protection from disease, insects, and fire; timber salvage; control of rotation; and site protection.

Chemical herbicides are exceedingly useful tools in intensive management of forest lands. Because of their effectiveness, low cost, and speed of application they save manpower sufficiently to be considered indispensable for forest management. Specifically herbicides show promise as aids to control of species composition, brush control, plantation establishment, production of nursery stock, chemical debarking, firelane and utility line maintenance, roadside maintenance and control of tree diseases, among other uses.

Much additional research will be required for most effective use of herbicides in forestry. Information is especially needed on basic physiological responses of different species of trees to herbicides. Additional studies are urgently needed on herbicide translocation, cuticle penetration, effects of herbicides on mycorrhizal fungi, fate and persistence of herbicides in forest soils, anatomical responses to herbicides, and basic growth responses of different species and ecotypes to herbicides applied at various dosages and under different environmental conditions.

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[2] Invitation paper.

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GRANULAR HERBICIDES[1]

W. G. Lovely[2]

While at the NCWCC at Kansas City, Missouri, in 1953, I discussed with representatives of several chemical companies the possibility of using granular herbicide formulations for weed control in corn and soybeans. Some of the people I talked to may be in this room today. Surprising as it may seem, no one was very interested, and I had difficulty obtaining a few pounds of granular 2,4-D to experiment with.

Today, just seven years later, granular formulations of nearly all herbicides are available to the general public. Farmer acceptance of these materials has been phenomenal. For example, there were practically no granular herbicides used in Iowa in 1958; while in 1960 it is estimated that approximately 1,000,000 acres of corn were treated with granular herbicides.

Research with granular herbicides has not kept pace with farmer acceptance. Prior to 1959 there were only 3 or 4 weed researchers working with granular materials, and most of them were spending only a small portion of their time with these materials. Because of this, there are many unanswered questions associated with granular herbicides.

In Iowa we have had some experiments with granular herbicides since 1954. We don't have all the answers but we do have some information that should be helpful. The remainder of this talk will be devoted to summarizing our findings.

Granular formulations of 2,4-D, CDAA, simazine, atrazine, and CDAA plus trichorobenzyl chloride (Randox T) applied at corn planting time performed as well as liquid formulations of the same compounds. Granular as well as liquid formulations sometimes failed to give control. The herbicide controls the weeds and when equal amounts of a herbicide are uniformly distributed over an area, the difference in control between granules and sprays is usually not significant.

The list of possible carriers is "as long as your arm." In the granular insecticide studies for borer control we found that carriers had little or no effect on control. Most of our weed control studies were with clay granules, and we found little or no difference between Attapulgite, Bentonite, and Pikes Peak clay carriers. Some mica granules were tried, but our results were erratic because of excessive drift.

We attempted to study the effect of distribution of granular herbicides over a given area. Granular sizes and percent formulations were used to vary the total pounds or numbers of granules per acre. Granular sizes of 30/60, 24/48, 20/40, 20/35, and 15/30 (mesh Attapulgite clay) were found to be equally effective when 2,4-D was used as the toxicant. Overall applications of 8, 10, 20, and 40 lb of granules per acre using 25, 20, 10, and 5 percent 2,4-D formulations respectively were equally effective. Using the 4 lb per acre rate of 2,4-D low volatile ester, 80 lb of granules were not materially better than 16 lb. Similar results were found when CDAA was used as a toxicant. It appears that the size of granules and percent formulation are important but not critical if the rate of toxicant is correct and the granules are uniformly distributed. Most granular formulations have been adequate for good application. However, the bag of material at the farmer level frequently contains a large number of fines or a large number of coarse particles. This makes accurate calibration or application difficult if not impossible.

The bulk of the granular herbicide applications have been made with planter attachments. The metering devices are for the most part the same as those used to apply granular insecticides. Previous tests with equipment to apply granular insecticides show that fluted feed, auger, fluted shaft, reciprocating chain, and gravity feed metering devices would apply clay granules equally well. The variations obtained within hoppers was in the order of one pound per acre while metering the equivalent of 10 pounds per acre. Between hoppers of the same machine two-pound variations sometimes occurred. Most of these metering devices require constant field speed and will apply granules only as accurately as farmers can maintain field speeds. Modified dusters were also tested and were usually less accurate than the others. Calibration tests with planter attachments for applying granular herbicides show similar results with slightly higher variations within and between hoppers.

Physical breakdown of granular materials while being metered by insecticide application equipment was also measured. Results of these studies where unimpregnated clay carriers were used show that breakdown did occur but that it was not excessive with any of the machines tested. When granular 2,4-D was used in similar tests with planter attachments the amount of granular breakdown increased. Although this breakdown of granules is unsightly, it appears to have little effect on control.

Granular herbicides give the farmer another material with which he can control weeds. They are more convenient than sprays for some applications and fit well into the planting operation. With most herbicides granules are as effective as sprays. Carriers, sizes, and percent formulations appear to have little effect on control of weeds. Uniform distribution and accurate calibration are necessary for good results. Application equipment causes some breakdown of granules, but weed control does not appear to be affected. Calibration and metering tests with various types of applicators and granular materials show that most equipment will vary up to 1 pound per acre at the 10 pound per acre rate of application where speed is held constant.

[1] Joint contribution from the Iowa Agricultural Experiment Station, Ames, Iowa, and the Agricultural Engineering Research Division, ARS, USDA. Journal Paper No. J-4043 of the Iowa Agricultural and Home Economics Experiment Station, Ames, Iowa. Project No. 1121.

[2] Agricultural Engineer, Agricultural Engineering Research Division, ARS, USDA.

GRANULAR VERSUS SPRAY APPLICATIONS OF HERBICIDES[1]

L. L. Danielson[2]

Granular herbicides hold the potential for greatly extending the use of herbicides but intensive research will be required to determine the specific conditions and equipment necessary for their most effective use.

Granular herbicides may be considered as including impregnated, built-up, and extruded granules. They include similar ranges of particle sizes but differ essentially in the methods and materials used in formulation.

Research has shown that granular and spray applications of herbicides each have their areas of most effective use. Thus, with some few exceptions, spray applications are more effective than granules in controlling growing weeds. Pre-emergence spray and granular applications made with equal uniformity are equally effective. Post-emergence granular applications of certain herbicides provide a physical selectivity not achieved with directed sprays and thus avoid or minimize crop injury. Granules are more effective in controlling germinating weeds under a heavy canopy of crop foliage because they sift down through the foliage to the soil where they are needed. Studies on the use of various herbicides in granular form have also shown that physical selectivity can only be achieved where the crop concerned has a measurable inherent tolerance to the herbicide and the granular formulation is used to enhance this tolerance.

Numerous investigators have made outstanding contributions to our understanding of the potentialities and limitations of granular herbicides in practical use on many weeds in crops and noncrop areas. Activity is continuing at a high level in this phase of granular herbicide research.

The critical research needs in granular herbicides at the present time lie in the area of basic investigations to determine: (1) the relationship between chemical, physi-

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cal, and herbicidal properties of herbicides and their performance and selectivity; (2) the effect of methods and materials used in granular formulations on their performance and selectivity; (3) the effect of environment including climate and soil composition on performance and selectivity; (4) the relation of crop and weed structure to performance and selectivity; and (5) the effect of time of application, with respect to crop and weed growth, on performance, persistence, and selectivity.

Expansion in these critical areas of basic research will aid materially in hastening the development of effective methods of using granular herbicides. Recent experience indicates that it will also be necessary to improve distributing equipment and to move toward standardization of volumes or weights of granular carriers to be used in distributing the active herbicide in the field.

[1] Abstract of Invitational Paper.
[2] Plant Physiologist, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, Beltsville, Maryland.

EFFECTS OF HERBICIDES ON RED PINE SEEDLINGS AND TRANSPLANTS

Winget, C. H., Kozlowski, T. T., and Kuntz, J. E.

The high cost of hand weeding has led to investigations of chemical weed control in forest nurseries. In 1960, the effects of a number of herbicides on the growth of three age classes of red pine seedlings were evaluated. In Griffith State Forest Nursery in Central Wisconsin, which is located on Plainfield sand, experiments of a randomized block design using ¼ milacre plots were established in standard nursery beds. The herbicides were applied with trombone sprayers as water emulsions or suspensions after the new shoots of seedlings began to harden off in June. The following herbicides were compared with untreated checks: atrazine; simazine; propazine; 2-chloro-4-isopropylamino-6-methylamino-*s*-triazine, G-30026; simetone; NPA; sesone; CDAA; CDEC; and EPTC. Soil moisture was maintained with an overhead irrigation system. Herbicide damage and mortality of seedlings were recorded. The plots were sampled in late August and the oven-dry weights of weeds and seedlings per plot were determined. Analysis of the data indicated that EPTC, CDEC, and propazine combined the most effective weed control with the least adverse effect on seedlings. It was found that older seedlings were less affected than younger ones by any of the herbicides tested. (Depts. of Forestry & Wildlife Management and of Plant Pathology, University of Wisconsin, in cooperation with Wisconsin Conservation Department.)

LEACHABILITY, MOVEMENT, AND PERSISTANCE OF HERBICIDES IN FOREST NURSERY SOILS [1] [2]

Kuntz, J.E.,[3] T. T. Kozlowski,[4] and R. R. Kilbury[5]

Chemical weed control in forest nurseries offers promising possibilities. The high value of the crop involved, the intensity of management, and the large costs of production, including that of hand weeding, which approaches one thousand dollars per acre per year, justify the increasing attention given to herbicides. Already Stoddard Solvent is used commonly to weed certain coniferous species in Wisconsin forest nurseries. Other herbicides have shown considerable promise.

Certain precautions, however, must be taken. Nurseries frequently are located on light, sandy soils. For many herbicides, the immediate margin of safety is small between dosages that provide satisfactory weed control and those that cause injury to coniferous seedlings or transplants. The persistence of herbicides and possible accumulations of phytotoxic residues are of special significance where beds are used repeatedly to grow a variety of tree species of different ages or for varying lengths of time. Greenhouse experiments were designed to study the leachability, movement, and persistence of certain triazine and urea herbicides in Wisconsin nursery soils.

In replicated experiments, simazine, atrazine, 2-chloro-4-isopropylamino-6-methylamino-*s*-triazine (Geigy 30026), and neburon were sprayed at 1 and 2 lb/A on cylindrical paper cartons holding about 1 qt either of Plainfield sand or of Vilas sandy loam. Control cartons without herbicide treatment also were prepared Different groups of 5 cartons each were leached immediately with 1, 2, 4, 8, or 16 surface inches of water. In each carton, 25 oat seeds were sown. Uniform amounts of water were added daily. Seed germination and dry weight production were measured.

The oat seeds germinated rapidly and uniformly, without noticeable effects of any herbicide. Seedlings were harvested 3 weeks after planting. Simazine, and especially atrazine, depressed top growth of oat seedlings at both dosages, with the greatest reduction at 2 lb/A rate. Growth depression occurred even when soils had been leached with 16 surface inches of water. Neburon had no evident growth depressing effect.

In other experiments, cartons were prepared as above, sprayed with the herbicides at 1 lb/A, and then leached with 2 surface inches of water. After 16 hours, the cartons were cut into sections 1 inch thick, and the first, third, and eighth sections from the top were sown with oats.

Seeds germinated well. Dry weight production of seedlings growing in the surface inch of soil was severely depressed, except with neburon, while growth in soil at the 2 to 3 inch depth or at the 7 to 8 inch depth was not decreased materially.

Later experiments measured the effect of atrazine on seed germination and subsequent growth of coniferous seedlings. Atrazine at 1, 2, and 4 lb/A was sprayed on replicated flats of Plainfield sand previously sown with red pine seed (*P. resinosa*). Seed germinated well at all dosages. Shortly, however, needle chlorosis, curling, and dieback developed generally, increasing in severity with dosage and time and resulting in 10% mortality at 1 lb/A and 50% mortality at 4 lb/A.

Post-emergence treatments with atrazine at the same rates were applied both to young red pine seedlings and to emerging white pine (*P. strobus L.*) seedlings, growing in flats of Plainfield sand and composted greenhouse soil.

Phytotoxic effects, including formative effects, developed more rapidly and to a greater degree on red pine than on white pine seedlings, especially at the higher dosages on composted soil. Injury increased with time; 1 month after treatment, all red pine seedlings were dead on both sand and composted soil at all rates. White pine seedlings were killed on treated soil and treated sand respectively, as: 4 lb/A, 82% and 90%; 2 lb/A, 67% and 91%; and 1 lb/A, 55% and 33%. Seedlings which had emerged prior to treatment (older seedlings) suffered less injury and mortality than did seedlings which emerged after treatment.

Severe phytotoxicity to oats planted at intervals thereafter demonstrated that atrazine remained in the upper soil layers for at least 3 months even after daily watering.

Similar trials were conducted with simazine applied at ½ and 1 lb/A rates to emerging and to young red pine seedlings approximately 7, 14, and 18 weeks after seeding. Older seedlings showed no apparent injury, although early treatments caused some reduction in their dry weight. Emerging seedlings, in contrast, suffered severe injury and mortality. More seedlings and

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greater dry weight of seedlings per plot resulted as application of the herbicide was delayed.

Such variations in response by different coniferous seedlings grown on different soils may well determine not only the herbicide which can be used, but also the rate, time, and method of application.

[1] Approved by the Associate Director of the Wisconsin Agricultural Experiment Station.
[2] Supported in part by the Wisconsin Conservation Department and in cooperation with the Geigy Chemical Corporaion and E. I. du Pont de Nemours and Company.
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FIRST-YEAR CONTROL OF WEEDS IN FOREST PLANTINGS

Glenn H. Deitschman and Emerson W. Pruett[1]

Several mechanical and chemical methods offering promise for weed control in new forest plantings were tested on three open-field sites in east-central Iowa in 1959. The soil types involved were Fayette silt loam, Waukegan loam, and Racine silt loam (poorly drained phase). Natural weed cover on these fields ranged up to 3 to 5 feet in height and composition varied somewhat by area. The principal weed species in order of importance were smooth bromegrass, blue vervain, and horseweed on the Fayette soil; giant ragweed, horseweed, timothy, and aster on the Waukegan; and giant ragweed, horseweed, blue vervain, and lambsquarters on the Racine.

Each treatment listed below was replicated twice on each area. Plots were 12 x 30 feet in size and surrounded by 5-foot buffer strips.

1. Check — no treatment.
2. Disked once at time of study establishment.
3. Mowed twice (early June and mid-July).
4. Cultivated by hand twice (early June and late July).
5. Simazin 1½ lb/A.
6. Dalapon (sodium salt) 20 lb/A plus 2,4-D (propylene glycol butyl ether ester) 2 lb/A.
7. Dalapon (sodium salt) 16 lb/A plus silvex 2 lb/A.
8. CIPC (granular form) 8 lb/A.

All plots except the check plots were thoroughly disked in mid-April. Application of herbicides and planting of four tree species were accomplished in early May. Each plot was planted with 10 seedlings each of eastern white pine, jack pine, and black walnut and 10 cuttings of native cottonwood. Effectiveness of the treatments was evaluated by periodic measurements of available soil moisture at 0-1 foot depth and light intensity at the tops of the planted trees, as well as by first-year survival and growth.

Weeds were satisfactorily controlled by the herbicides on all areas up to the middle of the growing season, but invading species rapidly became re-established thereafter. For the entire growing season, the two cultivations did best in limiting weed size and density, and two mowings were adequate to keep planted trees from being overtopped. Disking effects were very short-lived.

The composition of weed regrowth differed somewhat by area and treatment. Yellow foxtail was the principal invading species on plots receiving dalapon + 2,4-D, dalapon + silvex, cultivation, and mowing. For the first three of these treatments, foxtail was accompanied by giant ragweed on the Fayette area and velvet leaf on the Racine area. Simazin plots were also largely taken over by foxtail and velvet leaf on the Racine area. The major species entering all other treatment-location combinations were about the same as originally present.

Measurements of soil moisture at 0-1 foot depth taken in mid-summer revealed similar results among chemically-treated plots (table 1). On June 18, these plots averaged 20% greater available water present than within check, disked, and mowed plots, and on July 1, 25% greater. On the same dates, cultivated plots had 6% and 16% more moisture for plant use than did those receiving the chemical applications. Moisture levels on the cultivated plots at three subsequent times of measurement remained relatively high, but effects of the other treatments rapidly diminished and earlier differences were no longer apparent.

Table 1. Average available moisture in the upper foot of soil on all areas in the middle of the growing season.

Treatments	Available moisture in inches	
	June 18	July 1
Cultivated	2.39	2.45
Dalapon + silvex	2.35	1.94
Dalapon + 2,4-D	2.33	2.00
CIPC	2.19	2.14
Simazin	2.17	2.39
Disked	2.15	1.58
Check	1.89	1.68
Mowed	1.64	1.83

Light readings taken at the tops of planted trees averaged 9000 foot-candles or more for the entire growing season on cultivated and mowed plots. Based on measurements of light reaching white pine seedlings alone, simazin and dalapon + 2,4-D maintained light intensities of about 8000 f.c. up to mid-July; CIPC and dalapon + silvex plots averaged about 6000 f.c.; and disk and check plots had decreased to near 4000 f.c. These differences largely disappeared at later remeasurements.

Year-end survival and height growth of planted trees were generally best on cultivated plots, especially in the case of cottonwood. Under other treatments, results were not clearly defined. Heavy precipitation (50% above normal) during the first six months of the year, and the loss of effective chemical weed control in the last half of the growing season were probably responsible. No noticeable symptoms of chemical toxicity were observed in any instance.

In summary, two well-timed cultivations were most beneficial in maintaining good conditions of light and soil moisture on the three soils studied. Weeds recovered quickly from a single initial disking. Mowing gave no improvement in moisture availability although it did furnish satisfactory overhead release for planted trees. Dalapon + silvex and dalapon + 2,4-D eliminated weed cover quite well for a period of 45-50 days, but were ineffective thereafter. Simazin and, to a lesser extent, CIPC reduced competition by weeds satisfactorily for the same period. It seems likely that heavier applications of these latter two chemicals would have provided good control throughout the season without injury to the trees.

[1] Central States Forest Experiment Station, U.S.D.A. Forest Service.

THE USE OF HERBICIDES IN FORESTRY

R. R. Johnson[1]

The greatest successes in the use of herbicides in forestry have come in the control of competing woody plants, and in much of this country's forest area herbicides have become one of the standard tools of the forester. Aerial applicators release conifers on large

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holdings. Tractor mounted mist blowers are being used for pre-planting site preparation and conifer release. Tree injectors are being used for individual cull tree removal. The intensive use of these silvicultural practices indicates that herbicides have grown from the curiosity stage to full-fledged management practices.

In conifer release work, we are able to favor conifers at the expense of certain hardwoods. While we are not yet able to favor one hardwood species over another on large scale herbicide applications, the possibility has been indicated on a limited scale. Krefting, Hansen and Hunt[2] found that an aerial spray of 2,4-D would increase the percentage of desirable deer browse species in a brush population at the expense of less desirable browse plants. While this does not apply directly to selective hardwood stand conversion, it indicates that by manipulating herbicide, rate, volume, time, and technique, we may be able to influence the composition of hardwood stands with herbicides.

I believe it would be valuable to direct more of our attention to the control of herbaceous weeds, both in forest nurseries and in the establishment of plantations.

Plantation establishment in the North Central area is limited more and more by herbaceous growth rather than by woody plant competition. As we continue to utilize the richer sites we encounter weed problems which seriously limit the early growth of tree seedlings.

Much of the spruce planting in Minnesota, Wisconsin and Michigan is being done in old fields and abandoned farms. The serious grass problems which exist on these sites make some sort of site preparation necessary to prepare a planting bed. Mechanical site preparation by plowing furrows is usually satisfactory. However, a flush of vigorous broadleaf annuals soon occupy the disturbed area. Here are some possible solutions, using herbicides for this weed problem.

1. Treat bands in the planting area in the fall with a residual herbicide such as atrazine, diuron or simazine. Plant trees into these bands the following spring.
2. Plant trees in the spring and follow with a band application of atrazine, diuron or simazine. If heavy sods exist or weed growth has begun, amitrole or dalapon combined with one of these materials has proved beneficial. If mechanical site preparation is used, and one of the residual materials is applied immediately, it would not be necessary to add a translocated herbicide for knockdown.

If vegetation is controlled in the vicinity of spruce seedlings for two years, the plantation should become adequately established.

Broadleaf annuals and perennials are a primary problem in establishment of bottom land hardwoods in the North Central area. It will usually be necessary to apply a foliar-absorbed herbicide such as amitrole, dalapon or in some cases 2,4-D in combination with one of the residual herbicides to obtain adequate weed control.

Much work is currently being done on tree fertilization. Elimination of the herbaceous growth which is competing for nutrients already present in the soil results in increased tree growth. This is most noticeable in hardwood species.

The value of herbicidal treatment may be not only faster growth, but decreased mortality, enabling us to use lower planting densities.

Herbicidal treatments such as described above should be valuable wherever herbaceous growth is a limiting factor in seedling establishment and survival. One herbicide will not work in all areas, on all soil types or on all tree species, but the potential is great.

[1] Amchem Products Inc., Ambler, Penn.

[2] Krefting, L. W., Hansen, H. L. and Hunt, R. W. 1960. Aerial application of 2,4-D to improve the browse supply for deer. Proc. Society of American Foresters.

CHEMICAL WEED CONTROL IN FOREST PLANTINGS [1] [2]

Kuntz, J. E.,[3] T. T. Kozlowski,[4] J. Hovind,[5] and W. Bloomquist[6]

The survival and subsequent growth of young forest plantings are severely limited by weed and especially by grass competition. These effects are particularly detrimental during the first year or two. Later, after trees have become well established, they may tolerate a moderate amount of weed competition and eventually will shade out most competition. Still, in Wisconsin where plantings frequently are made on abandoned farm lands bearing heavy sod, grass competition may suppress not only new plantings, but also older plantings which have become overgrown. This latter situation presents new and different problems, in some respects more challenging than those common to new plantings. In both, weed control by mechanical means has certain limitations.[7]

Investigations initiated in 1948 by the senior author have tested many herbicides and combinations of herbicides with encouraging results.[8]

In review, these early experiments showed that both survival and growth of trees planted in heavy, unplowed sod were reduced to varying degrees regardless of subsequent elimination of grass above ground. Hardwood tree plantings suffered more from early weed and grass competition than did conifers, although conifers also responded to release from weed competition. Fast growing poplars (selections of *Populus deltoides* Bartr.) proved to be excellent test hardwoods because of their ability to root from dormant cuttings, their unusual sensitivity to site conditions, and their marked response to release from weed competition. For example, on fertile loam soils, poplars planted in undisturbed sod either died or remained small, spindly and chlorotic; while on plowed and weeded plots, they commonly survived almost 100 percent and grew 4 to 7 feet during the first season. On light sand soils, even with less grass and weeds present, poplars suffered more from competition. In unplowed, unweeded check plots, few poplars lived and the terminal growth of survivors was less than 6 inches. On plowed, weeded plots, poplars survived from 80 to 100 percent and terminal growth was over two feet.

Site factors such as soil type, fertility, soil moisture, water table, and weed species originally present modified results considerably. The margin of safety between concentrations of herbicides necessary to kill weeds and those which caused injury to trees usually was much less on sand than on heavier soils as loams and mucks. Older, established trees, however, tolerated concentrations of herbicides which frequently injured newly planted trees.

In the early experiments, plots were plowed, disked, and dragged prior to planting with dormant poplar cuttings and jack and red pine transplants. Most herbicides were applied as pre-emergence sprays in water at 200 gal/A immediately after planting, either to the entire plot or to a limited area around each tree. With all herbicides care was taken to avoid spraying of tree foliage. On light, sandy soils, monuron at 5 lb/A gave good weed control for 1 season; at 10 lb/A, for 2 seasons; and at 20 lb/A, for approximately 3 seasons, although all trees were killed the first season. Replantings the second season were killed in the 20 lb/A plots and replantings in the third year were severely injured. Monuron at 2 lb/A gave variable weed control and at 4 lb/A injured trees. Fenuron at 2 lb/A gave poor weed control with rapid recovery and at 4 lb/A injured trees severely. Diuron at 2 lb/A frequently gave satisfactory, first-season weed control with no apparent injury to trees. At 4 lb/A diuron caused some injury to newly planted pine, and at 5 and 10 lb/A diuron severely injured 6-year-old pine. Late spring applications of diuron at 2 lb/A with dalapon at 10 and 20 lb/A or with CIPC at 10 and 20 lb/A also were effective without injury to trees. Combinations of 2, 4-D at 4 lb/A with

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dalapon or CIPC showed promise. Late spring applications of erbon at 20 and 40 lb/A gave excellent, first-season weed control with no injury to trees. TCA at 20 and 40 lb/A, alone and in combination with 2, 4-D, gave good initial weed control, but even 10 lb/A killed all pine and caused some injury to poplars. Low rates of sodium chlorate, anhydrous borax (Borascu), a CBM (Polybor-chlorate), and ammonium sulfamate either injured or killed the trees. Other materials gave initial control of weeds but allowed variable regrowth by later summer: 2,4-DES, 2,4,5-TES, PCP, AMS, CDAA, 2,3,6-TBA, and others. In loam and muck soils, monuron and diuron at 2 and 4 lb/A were used without injury to trees. On loam, monuron at 10 lb/A gave excellent weed control, but killed both pine and poplar the first year and severely injured replantings the second year. On muck, older trees tolerated monuron at 8 lb/A, combinations of monuron and dalapon at 10, 20, and 40 lb/A, and erbon at 20 and 40 lb/A. Combinations of 2,4-D, dalapon and CIPC were effective. TCA at 10 lb/A or above injured pines severely.

In more recent experiments, selected herbicides were applied with small, powered sprayers in bands 2 feet wide over the row just before hand planting or just ahead of a machine planter. In the latter case, the sprayer was mounted on the planter tongue. In 1957 and 1958, on sandy soils, simazine at 2, 4, and 8 lb/A gave fair to excellent first-season weed control, variable injury at the 8 lb/A rate, and an average tree survival of 84%. These results compared to a survival of less than 50% in unweeded plots, 65% in plots hand-weeded in strips, and 85% in plots hand-weeded over-all. Atrazine at 4 and 8 lb/A also gave satisfactory weed control, but with some injury to pine at the higher rate, and a survival of 78%. Diuron trials at 2 and 4 lb/A confirmed previous results. Mixtures of simazine with erbon, dalapon, or diuron combined quick weed kill with persistence into the second season, especially with diuron. Other herbicides as amitrole, sesone, CDAA, and endothal failed to give satisfactory weed control. TCA alone or monuron-TCA at 8, 16, and 32 lb/A severely injured pines. In 1959, 2-chloro-4-isopropylamino-6-methylamino-*s*-triazine (G-30026), neburon, and fenuron at 2, 4, 8, and 12 lb/A gave fair to good weed control, respectively, with only slight injury to trees at the highest rate.

In similar trials in 1960 on new plantings of Norway spruce, first-year weed control and survival percentages were: prepared and hoed plots, good, 85; untreated, none, 77; simazine at 6 lb/A, good, 86; simazine at 6 plus dalapon at 6 lb/A, good, 89; atrazine at 6 lb/A, fair, 70; scalped only, fair, 84%.

Current research has demonstrated the effectiveness and feasibility of chemical herbicides in reducing or eliminating weed competition in young forest plantings. Since machine planting accounts for more than ¾ of over forty million trees planted annually in Wisconsin, trees could be planted and herbicides applied in one operation. Much more information is needed on effective herbicides, their mode of action on trees of different species and ages, their movement and persistence in different soils under different conditions and their possible effects on other plants, animals, and soil microorganisms.

[1] Approved by the Associate Director of the Wisconsin Agricultural Experiment Station.

[2] Supported in part by the Wisconsin Conservation Department in cooperation with several chemical companies.

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[7] Hovind, H. J. 1959. The role of herbicides in establishing coniferous plantations. Proc. 16th North Cent. Weed Control Conf. p. 42.

[8] Kuntz, J. E., and A. J. Riker. 1954. Control of weed and grass competition in forest plantations. Proc. 11th North Cent. Weed Control Conf. p. 116-117.

AERIAL SPRAYING TO RELEASE SHORTLEAF PINE FROM AN OAK-HICKORY OVERSTORY

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Vast acreages of land in the Ozarks are occupied by tree species of low economic value. To improve productivity of this land the brush often must be removed and the land converted either to grass or to tree species of higher economic value. Shortleaf pine (*Pinus echinata*), a valuable timber species, grows well on most of this land, but it is often overtopped by poor-quality oak and hickory species. Most methods of removing these unwanted trees are costly and the relative inaccessibility of much of the land makes such control impractical. Aerial application of herbicides overcomes these difficulties to some degree and can be used for rapid release of large areas.

This study was initiated in 1955 to compare aerial applications of propylene glycol butyl ether ester of 2,4,5-T and silvex for the release of shortleaf pine. An area that had been planted to pine in 1942, was selected in the Clark National Forest. The overstory consisted mainly of black oak *(Quercus velutina)*, blackjack oak, *(Q. marilandica)*, white oak *(Q. alba)*, post oak *(Q. stellata)*, and hickory *(Carya spp.)*. Aerial applications of 2,4,5-T and silvex were made to 9-acre plots at the rate of 2 lb/A in 5 gallons of oil. The spray plane had a wingspan of 28 ft. and flight strips were 26 ft. wide to permit overlapping of swaths.

Four hundred to 600 trees were numbered in a transect laid out across each plot. The species and size of each tree were recorded on a data-processing card. Yearly estimates of defoliation and notations of sprouting were made for each tree.

In 1956, the percentages defoliation of blackjack and post oaks were about equal for both herbicides. Silvex was superior to 2,4,5-T in defoliating black oak, but 2,4,5-T was better on white oak and hickory. Over the four year period black oak and white oak regained foliage more rapidly than other species regardless of the herbicide treatment. Hickory recovered from treatment with silvex but not from treatment with 2,4,5-T. Data taken in 1959 show that a second application of herbicides in 1957 increased defoliation of all species except hickory treated with 2,4,5-T. After the second application, defoliation of all species was greater with silvex than with 2,4,5-T.

Browning of needles occurred on pine trees after each herbicide application, but few trees were killed. The single application was sufficient to tip the ecological balance in favor of the pines so that they recovered and grew rapidly. Although many hardwoods regained foliage after the single application, it was judged that the pines were adequately released from the hardwood overstory. Two applications of herbicides killed more hardwoods than one application. This second application would be particularly desirable where grass was to be released or where pine trees were to be freed from competition for water and nutrients.

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WEED CONTROL IN SHRUBS PLANTED FOR WILDLIFE

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The Game Division of the Michigan Department of Conservation plants about 400,000 shrubs annually in southern Michigan game areas for the improvement of wildlife habitat. These plantings furnish the "brush" that is so important to deer and nearly all species of small game. These plantings are scattered throughout many game areas. Successful establishment of shrub plantings depends to a large extent on controlling weeds. Cultivation has been the usual means of controlling weeds, but transporting men and equipment to scattered plantings several times a season makes the operation costly. We began testing pre-emergence herbicides in 1958 to obtain season-long weed control from a single treatment. Simazine was used because of its long residual effect.

Dr. S. K. Ries, Department of Horticulture, Michigan State University, put out field tests for me in May, 1958. Pounds per acre rates of herbicides applied to multiflora rose and coralberry included: wettable simazine at 2 and 4, granular simazine at 4, dalapon at 5, neburon at 4, sesone at 4, and simazine-dalapon at 2 and 5.

Weed control was generally good, but chlorosis began to appear within a week of application, and within a month, damage was severe and extensive.

Factors that contributed to excessive leaching of herbicides into the shrub root zone included: (1) application to freshly-hoed soil, (2) light sandy soil having low organic content, and (3) heavy rainfall soon after treatment. A nearby weather station reported more than 2 inches of precipitation in the 14 days following treatment.

Ratings made in June, 1959 showed that granular simazine at 4 lb/a. gave good weed control and damage was negligible in 3 or 4 plots. Growth was rated as average. Two pounds of wettable simazine caused much greater damage and afforded somewhat poorer weed control.

A 12-treatment experiment compared summer fallowing with herbicide treatments for site preparation prior to planting, and cultivation was compared with simazine applications for weed control after planting. There were 4 replications of randomized plots.

Table 1. Height and survival of honeysuckle and multiflora rose, 1959

Treatment (lb/A)					Performance	
Summer 1958	Fall 1958	Spring 1960	Spring 1960	Summer 1959	Average height* (inches)	Survival (per cent)
Summer fallow	X	Disk	X	Cult.	38	78
Summer fallow	X	X	2 simazine	X	32	60
Summer fallow	X	X	X	Cult.	30	63
Summer fallow	X	Disk	2 simazine	X	30	50
X	10 dalapon	Disk	X	Cult.	28	60
X	10 dalapon	X	2 simazine	X	26	44
X	10 dalapon	Disk	2 simazine	X	26	39
X	10 dalapon 4 simazine	X	X	X	23	35
X	10 dalapon 2 simazine	X	X	X	22	35
Summer fallow	X	Disk	X	X	21	68
X	X	X	4 simazine	X	21	49
X	10 dalapon	X	X	X	18	43

* Measured 10/26/60
X Indicates no treatment

Summer fallowing was much superior to herbicide treatments for site preparation. We did not plow following fall applications of dalapon as recommended on the label. The cultivated plots were hand-hoed 3 times the first season. There was no effort toward weed control in 1960. In contrast to the 1958 season, damage was not severe although the soil was Plainfield loamy sand, a soil low in organic matter. Again, a nearby weather station recorded 2.02 inches of rain in the 14 days following treatment.

In 1960, shrub planting experiments were initiated in 1959 food patches of corn and buckwheat. We hoped to successfully substitute this practice for summer fallowing because food patch development would be much more beneficial to wildlife than summer fallowing.

Six treatments were used. Plots were randomized. Each plot contained 10 plants each of autumn olive, multiflora rose, western sandcherry, and silky dogwood.

Table 2. Performance of shrubs planted in year-old corn and buckwheat, 1960

Treatment	Average height* in inches				Survival in per cent			
	Autumn olive	Multiflora rose	Sand cherry	Silky dogwood	Autumn olive	Multiflora rose	Sand cherry	Silky dogwood
No treatment	14	13	9	10	98	88	93	95
Disk-no weed control	17	14	10	12	100	95	88	97
Cultivate	18	13	11	13	93	98	98	93
Disk and cultivate	20	16	11	12	88	100	97	95
2 lb. wet. simazine	13	14	11	14	77	96	100	93
Disk—2 lb wet. simazine	10	14	10	12	60	87	96	96

*Measured September 14, 1960

In another experiment, 8 treatments featured varying amounts of both wettable and granular simazin compared with no weed control and cultivation by hand hoeing in freshly-prepared soil. Treatments were made to randomized plots using 10 shrubs of each species. There were 3 replications.

Table 3. Performance of shrubs planted in freshly-fitted soil, 1960

Treatment lb/A	Average height* in inches				Survival in per cent			
	Autumn olive	Multiflora rose	Sand cherry	Silky dogwood	Autumn olive	Multiflora rose	Sand cherry	Silky dogwood
No weed control	12	13	11	10	100	83	100	87
Cultivate	16	14	13	14	100	100	100	83
1 wet. simazine	10	10	11	12	67	87	83	77
2 wet. simazine	9	12	10	14	30	93	73	80
3 wet. simazine	8	12	9	12	17	77	70	67
4 wet. simazine	10	9	9	11	30	77	27	73
2 gran. simazine	16	16	15	16	80	100	97	97
4 gran. simazine	17	13	13	13	65	100	95	75

*Measured September 14, 1960

In searching for an inexpensive one-treatment method of weed control in shrub plantings, we applied simazine as a pre-planting treatment, although the simazine label recommends it for nursery stock "on plants established one year or more". Results were encouraging at times, but considerable damage, amounting to total losses in some cases, was experienced.

Because we need efficient and inexpensive weed control immediately after transplanting, and because most of our sites are on light, sandy, low-organic-matter soils, damage is likely to be severe. Anything that increases percolation increases damage. Data in each table support the probability that fitting immediately prior to planting, although a good weed control measure, increases damage because it increases leaching. Performance was

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better in granular treated plots because the granules resisted leaching better than wettable simazine.

Simazine applications gave good control of annual weeds in shrub plantings, but in a few plots perennial weeds were troublesome. They should be eradicated prior to planting.

A screening experiment is needed to determine the relative sensitivity of different species. Autumn olive is highly sensitive to simazine, and coralberry, nannyberry and honeysuckle, only slightly less sensitive. Multiflora rose and western sandcherry are somewhat resistant, while silky dogwood is the most resistant species tested.

This is a progress report. The search continues for a method of using simazine that will give good weed control immediately after transplanting with only occasional damage.

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OAK WILT CONTROL WITH[1] [2] SOIL FUMIGANTS

Kuntz, J. E.[3] and C. R. Drake[4]

In Wisconsin, the oak wilt fungus *(Ceratocystis fagacearum* (Bretz) Hunt), commonly spreads from an infected oak to adjacent healthy oaks through underground root grafts. Control of such tree-to-tree spread has been achieved either (1) by poisoning with sodium arsenite all healthy oaks within 25 to 50 feet of infected trees or (2) by cutting or breaking all roots joining such trees. Various mechanical equipment has been used, including root breakers, trenchers, ditch diggers, and sub-soilers.

In numerous, repeated experiments since 1952, soil injections with methyl bromide and with SMDC (Vapam) have killed portions of roots of northern pin oaks *(Q. ellipsoidalis,* 4 to 10 in dbh) growing in the deep, porous Plainfield sand of central Wisconsin. Herbicides were injected into 1½ in. crowbar holes placed between trees in a single line at 1 ft. intervals. The holes were made in succession to depths of 1½, 2, 2½, and 3 ft. One pound of methyl bromide treated 5, 10, 15 or 20 linear ft. A modified MacLean Rodent Dispenser introduced the fumigant. Vapam (formulation), first diluted 1 to 10 with water, was used at rates of 50, 100, 200, 400 ml of the diluted solution per hole. In some experiments, methyl bromide was discharged under an air-tight polyethylene or insulating-paper cover placed around individual, infected trees.

Sections of roots were killed rapidly by both fumigants at all dosages. Less injury occurred to nearby trees and ground cover plants at the lower dosages. Solutions of dyes, poisons, and radioactive isotopes did not pass through the killed sectors of intact roots because tyloses rapidly plugged the xylem vessels in a narrow zone between the living (white) and dead (brown) portions. Flow of water under slight pressure through cut root sections was reduced drastically by the plugged sectors. In plots with artificially inoculated oaks closely bordering one side of the fumigation zones, oak wilt did not develop across the fumigation zone while several trees on the same side wilted. Both fumigants have prevented further local spread of the oak wilt fungus from natural infection centers.

[1] Approved by the Associate Director of the Wisconsin Agricultural Experiment Station.

[2] With support by the Wisconsin Conservation Department and in cooperation with the Nekoosa-Edwards Paper Company, the Dow Chemical Company, and the Stauffer Chemical Company.

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EVALUATION OF WEED INFESTATIONS UNDER FIELD CONDITIONS[1]

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Accurate evaluations and descriptions of weed infestations are basic to the whole experimental procedure in studies of the nature and extent of crop yield reductions due to weed competition. They are similarly important in herbicide evaluation tests. Among the major requirements which should be met in such studies, these are important. (1) Weed species must be typical of the area and of the crop. (2) Distribution or density of weed populations should be reasonably uniform over the experimental area. (3) The infestation must be measured or assessed accurately by methods which have application over a range of conditions and which can be used and applied by other investigators. (4) Severity of infestations should reflect closely the kinds of infestations found commonly in actual production fields. This latter point is extremely important when experiments are undertaken to obtain estimates of the economic losses due to weed competition and contamination. In detailed studies of the nature of plant competition, the need to intensify competition may require heavier levels of weed infestation. Extremely heavy stands of weeds are useful too in field screening of herbicides.

Establishment of suitable weed infestations is sometimes a major undertaking. Naturally occurring infestations are ideal, provided they can be modified to the requirements of the experiment. Seedings of the desired weed species are alternatives. For herbicide trials, seed should be scattered over the experimental area the previous fall to more closely approximate natural conditions. The successful establishment of both naturally occurring and planted infestations from seed demands good agronomic practices. Adequate supplies of reasonably pure seed are needed and seed dormancy must be broken in some species. Seed bed preparation must be optimum for both the crop and weed seeds. After emergence, the weed seedlings should be thinned by hand or by mechanical cultivation to the proper levels. Selective herbicides may be used to eliminate some species, but the technique has limited application in ecological studies in general.

Measuring the size or severity of a mature infestation and relating it to the observed crop yields is a difficult and demanding part of plant competition research. It is equally important to the success of herbicide evaluation under field conditions. Generally the yield of the crop is easily obtained. Seed yields of weeds are difficult to obtain due to uneven ripening and shattering. Harvesting the entire above ground plant parts of the weeds, shortly before maturity, is an effective and feasible method. Counts of weeds may provide some indication of the severity of infestations, but evaluation on this basis alone may lead to serious bias in the estimates of crop yield reductions. Counts alone have limited application to conditions other than those of the experiment where the counts were made. Similarly with scoring and rating systems. Many such systems have been devised to provide quick evaluation of weed infestations. They are most useful however, only to the investigator who uses them, since they are difficult for others to interpret. Yield of weeds is a good measure of total growth and hence provides a reliable biological basis upon which to compare infestations and to base future estimates of crop yield reductions. A combination of both counts and yields may be most useful. When the yields of weeds are obtained, the clarity of results may often be improved by expressing them in the units, bushels of crop yield reduction/cwt. weed infestation. In large plots, where only estimates of weed yields are needed, reliable sampling systems can be devised.

In crop-weed competition studies the factors of shading and competition for moisture and nutrients must be recognized. When only one of these is under study, the effects of the others may be minimized or accounted for. Differential fertilization, irrigation and soil surface

protection methods may be used. Shading effects may be minimized in low growing crops such as soybeans by the proper choice of weed species. In corn, most weeds are shaded by the crop, although the use of dwarf corn may minimize shading.

Weed species should be relatively easy to grow and not too difficult to handle at harvest time. Crop varieties should be adapted to the area, and resistant to diseases, lodging, etc. In studies with corn and weeds, the use of a hybrid which does not have barren stalks at high planting rates is almost essential to the success of studies where corn plant populations are a major variable.

Data obtained from crop-weed competition studies are often the basis for estimates of weed losses over a range of production conditions. Generalizations of this nature should be tempered by caution and judgement. The factors of soil fertility, soil moisture availability and seasonal distribution, species, numbers and growth of weeds, and crop plant populations all have a bearing on the final outcome of crop-weed competition. Accurate descriptions and characterizations of these factors as related to crop-weed ecology studies will facilitate interpretation of the data by others, and will provide research information vital to valid estimates of yield reductions due to weeds.

[1] Joint contribution from the Iowa Agr. Exp. Sta. Ames, Iowa, and Agricultural Engineering and Crops Research Divisions, ARS, USDA.

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HERBICIDAL PROPERTIES OF 2,3,6-TRICHLOROPHENYLACETIC ACID[1]

L. E. Anderson[2]

Formulations of 2,3,6-trichlorophenylacetic acid (fenac) have been compared with 2,3,6-trichlorobenzoic acid (TBA), polychlorobenzoic acid (PBA) and various other herbicides in field bindweed control experiments conducted during the past three years. Various rates and dates of application have been observed at three locations in eastern Kansas. During the same period, fenac has been included in other bindweed control experiments located at Hays, Kansas, and Bushland, Texas.

This work was initiated in 1958 when post-emergence applications were made to plot areas located near Westmoreland and Canton, Kansas. A third location near Wakefield, Kansas, was added in the spring of 1959. In addition to spring treatments at each of the locations, a fall application prior to frost was made at Canton in 1958 and a soil application was made at Wakefield in December, 1959. Soils at each location were slightly acid, silty clay loams. Three replications were used for all treatments; plot size was 1 square rod.

Effectiveness of the various treatments (percentage of bindweed control) is included in Tables 1 and 2; crop response to soil residues is summarized in Table 3.

Table 1. Bindweed control at Canton and Westmoreland, Kansas; applications made in 1958.

Herbicide	Pounds per acre	Canton applied		Westmoreland	Average control
		June	October	applied June	
		Pct.	Pct.	Pct.	Pct.
Fenac	5	7	8	70	28
	10	15	37	83	45
	20	62	63	83	69
TBA	10	3	15	57	25
	20	10	55	92	52
	40	65	90	92	82
PBA	10	....	10	80	45
	20	....	20	63	41
	40	....	80	87	84

Table 1 indicates that bindweed was more difficult to control at Canton. Differences in effectiveness of spring and fall applications at Canton may be attributed to residual effects of the spring treatment. Fenac at 20 pounds per acre was more effective than either TBA or PBA at the same rate.

Table 2. Bindweed control at Wakefield, Kansas; applications made in 1959.

Herbicide	Pounds per acre	Control, applied June	Pounds per acre	Control, applied December
		Pct.		Pct.
Fenac	10	92	6	40
	15	93	12	72
	20	98	24	95
TBA	10	73	6	13
	15	93	12	47
	20	88	24	78

The data in Table 2 report degree of bindweed control for two and one growing seasons following herbicide applications. After two growing seasons, fenac, in general, gave better control than TBA at comparable rates. This was also true for the winter applications preceding the 1960 growing season.

Corn and grain sorghum were planted in late May, 1960 across all plots included in the areas treated in June and December, 1959.

Table 3. Effect of soil residues following applications of fenac and TBA to field bindweed, 1959.

Herbicide	Applied June, 1959			Applied December, 1959		
	lb/A	Corn % stand	Grain sorghum % stand	lb/A	Corn % stand	Grain sorghum % stand
Fenac	10	23	77	6	33	40
	15	7	27	12	12	7
	20	18	23	24	3	0
TBA	10	35	78	6	30	65
	15	43	73	12	20	75
	20	28	63	24	3	10

Data in Table 3 indicate that both corn and grain sorghum were affected in varying degrees by the herbicide residues, but considerably more corn and grain sorghum grew in the area treated 12 months before planting than in the area treated in December. This indicates that fenac and TBA do not leave toxic residues in the soil for as long a period as various other soil sterilants. In crop land this would be a distinct advantage. Under the conditions of this experiment, grain sorghum was more tolerant than corn to the chemical residues.

Average percentages of control in various bindweed experiments using fenac over a three-year period at Hays, Kansas were 54, 76, and 85 for rates of 8, 12, and 16 lb/A. Two year averages at Bushland, Texas were 79, 88, and 97 for rates of 5, 10, and 20 lb/A. Overall results at the Canton, Westmoreland, and Wakefield, Kansas locations were 31, 60, and 80 percent control at 5, 10, and 20 lb/A. In comparing over-all results for the three year period at the Canton, Westmoreland, and Wakefield locations fenac at 10 lb/A was as effective in controlling bindweed as TBA at 20 lb/A, and almost as effective as PBA at 40 lb/A.

In other experiments, fenac applied at 1 and 2 lb/A pre-emergence gave 75 and 92 percent control of annual weeds in corn but with slightly reduced yields. Fenac applied at 4 lb/A severely injured the corn. In other preliminary experiments fenac failed to control tanweed at 10 and 20 lb/A and established johnsongrass at 4, 8, and 12 lb/A. Fenac gave moderate control of Russian knapweed at 20 lb/A.

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THE EFFECT OF ATRAZINE ON THE CARBOHYDRATE LEVELS IN RHIZOMES OF QUACKGRASS

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Following outstanding results in the control of quackgrass with atrazine a study was undertaken to determine if there were any changes in the carbohydrate content of the rhizomes following treatment. Conventional field plots were established on a well developed quackgrass sod in August 1959. Treatments of 2 and 4 lb/A with and without nitrogen were applied as a spray application. All plots were plowed in late May, planted to corn, treated to control annual weeds and observed for control of quackgrass without further tillage. Rhizome samples were made periodically by taking a uniform volume of sod from each plot. The rhizomes were screened, washed, dried, and analyzed for total reducing sugars. Extraction and hydrolysis were made in 2% HCl at 85°C.

The total carbohydrate content of untreated rhizomes showed relatively little change during the season from the normal of about 50% carbohydrate although a slight drop occurred during a period of regrowth. Fall treatments showed a marked decline in carbohydrate during the fall months to near 20%. This trend continued during the early spring on treatments of 4 lb/A but was reversed in application of only 2 lb/A. Application of nitrogen at the time of treatment increased the rate of depletion and gave lower levels at all dates.

The rhizomes of quackgrass maintained a total concentration of about 6000 lb/A (dry weight) in the untreated sod. Following treatment with atrazine this amount was reduced to 3800 lb/A with 2 lb. and 2600 lb/A with the 4 lb. treatments. When expressed as lb/A of carbohydrate the levels are 2700, 1100, and 400 lb. for the untreated, 2, and 4 lb. rates, respectively.

Spring treatments were made on similar sod before regrowth had occurred in April. Rates of 1, 2, and 4 lb/A of atrazine, in combinations with nitrogen application and splitting of rates into two applications at 3-week intervals, were applied. Samples were taken as from the fall treatment. Five weeks after treatment one-half the area was plowed and planted to corn, the remainder left undisturbed for further sampling.

Early reduction of carbohydrate was similar at all rates but showed marked differences at the end of one month. Splitting of applications gave a greater reduction in carbohydrate than similar amounts applied in a single application.

Control of quackgrass was associated with the extent of carbohydrate depletion. With fall treatment, rates of 4 lb/A gave excellent control while the 2 lb. rates and considerable regrowth. Spring treatments all showed regrowth after plowing but rates totaling 2 lb/A or greater soon became chlorotic and died. No differences in regrowth were measurable between nitrogen treated and non-treated at a given rate of atrazine.

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CHEMICAL FALLOW IN DRYLAND FARMING[1]

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Chemical fallow research in the Great Plains area has yielded much fundamental information about the effectiveness of tillage methods and residue conservation on soil moisture storage, soil temperature and crop yields. The toxicity of various herbicides to weeds and volunteer crops has been determined. Effects of herbicides on moisture utilization by plants have also been evaluated. However, a practical method of chemical fallow has not been devised.

Some of the first research with chemical fallow at the Southwestern Great Plains Field Station was conducted to determine if maximum residue conservation with chemical fallow would decrease evaporation losses during the fallow period. During a 10 month fallow period, on plots were runoff was prevented, moisture storage was not materially affected when satisfactory weed control was obtained with either a disk, sweep plow, or heerbicides.[3,4]

In the course of these investigations it was observed that the soil surface of bare disked plots dried much more rapidly following rain than mulched plots maintained with chemicals or sweep tillage. Subsequent studies in which the drying pattern of the top 6 inches of soil was determined at daily intervals after rains, showed that this moisture difference was restricted to the top 2 inches of the soil profile and was most pronounced in the top ½ inch of soil[5]. During summer months the surface of mulched plots remained wetter than bare plots for about one week after a rain. Temperature determinations during the summer made at the 1 and 6 inch depths showed that the average soil temperature was higher on disked plots than on sweep tillage or chemically fallowed plots. Daily maximum temperature readings at the one inch depth were usually the same for the three tillage methods during and following a rain until the surface of the disked plots dried. After drying, the surface temperature of the disked plots usually exceeded the maximum air temprature by 5 to 10 degrees. Surface temperature of the mulched plots seldom exceeded maximum air temperature. These studies pointed out that the difference in the drying pattern between bare and mulched soil was due to the fact that residues (a) decrease wind speed and vapor transport away from the soil surface and (b) lower soil temperature reduces the vapor pressure of the soil water. After the soil surface dries, moisture loss from the soil profile is determined by intrinsic soil factors which control moisture movement to the soil surface.

Field studies also were conducted on large plots in which chemical weed control was compared to sweep tillage during the fallow period of a wheat-sorghum-fallow rotation[6]. Inconsistent and slow weed control with herbicides resulted in more soil moisture storage with sweep tillage than with chemical fallow. Reduced yields of wheat and sorghum reflected the lower moisture storage under chemical fallow.

Concurrently with research to determine the effect of chemical fallow on soil properties and crop production, studies were conducted to find suitable chemical methods for control of weeds, volunteer wheat and volunteer sorghum.[6] Foliage applications of ester formulations of 2,4-D usually killed broadleaf weeds, but dalapon, TCA, amitrole, monuron, or fenuron did not usually control stinkgrass or witchgrass. Pre-emergence applications of herbicides were not successful in controlling either grasses or broadleaf weeds. Controlling volunteer wheat and volunteer sorghum was as difficult as controlling grass weeds. Adding a wetting agent to dalapon and amitrole increased the toxicity of these herbicides to wheat. Anitrole did not injure sorghum but was more toxic to wheat than dalapon. Chemical control of weeds under dryland conditions proved to be difficult because limited soil moisture reduced plant vigor and susceptibility to herbicides. Herbicides were most effective when applied to very young plants which had just emerged after a rain. When weeds or volunteer crops were allowed to grow and deplete surface moisture they became very tolerant to herbicides.

Weeds treated with herbicides die more slowly than those which are plowed. Because of this inherent problem in chemical fallow, greenhouse studies were conducted to determine the effect of herbicide application on transpiration from sorghum and rough pigweed. Treated and untreated plants were grown in quart oil cans and were weighed daily to determine moisture losses. Evaporation was prevented by sealing the soil surface with a

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low melting point wax. The pigweed, treated with ¼ pound per acre of an amine salt of 2,4-D, were not killed but stunted for 16 days. Transpiration was reduced one-third while plant growth was retarded, but became normal when the plants recovered. During the 16-day period, the untreated plants used the equivalent of 1.5 acre inches of water. Stem tissue of 5-inch sorghum plants treated with herbicidal oil dried out and stopped transpiring in 2 days. In the same study sorghum treated with 15 pounds per acre of dalapon did not stop transpiring for 18 days.

Research to date indicates that chemical fallow will not become a widespread practice until satisfactory herbicides are found which will kill weeds as efficiently as mechanical tillage. Development of such herbicides should be a tremendous challenge to the chemical industry in that they would have potential use over 100 million acres of the Great Plains area.

Development of suitable herbicides for weed control during the fallow period probably should be directed in several directions including the following:

1. Development of an inexpensive effective grass killer which could be combined with 2,4-D. Such a mixture could be used to minimize or eliminate tillage for weed control.
2. Development of a desiccant for foliage applications or a soil sterilant which would kill all plant growth but would be dissipated before the next crop was planted.
3. Development of an herbicide which would be lethal to a majority of plants but not toxic to specific crops. Such an herbicide would be particularly valuable if its toxic effects persisted in the soil for several years.

If economical and effective herbicides can be developed, chemical weed control during the fallow period will result in improved residue conservation for control of wind and water erosion and improved seedling establishment throughout the dryland farming areas.

[1] Joint contribution of the Texas Agricultural Experiment Station and Soil and Water Conservation Research Division, ARS-USDA. Approved as TAES T.A. 3667.
[2] Agronomist, Texas Agricultural Experiment Station, Bushland, Texas and Soil Scientist, Soil and Water Conservation Research Division, ARS-USDA, Fort Collins, Colorado, respectively.
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THE EFFECT OF BARBAN (CARBYNE) APPLIED AT TEN STAGES OF GROWTH ON WILD OATS AND SELKIRK WHEAT

George Friesen[1]

In order to ascertain the most effective spray period for wild oats, an experiment was designed to permit spraying at short intervals over a two week period. Ten dates of spraying were included, the first date coinciding with the day of emergence and the last spraying applied two weeks later. The experiment was conducted on wild oat infested land near the University of Manitoba. Selkirk wheat was seeded on the area on May 12 and emerged on May 19. The bulk of the wild oats emerged on May 20. Unusually good growing conditions prevailed and at the last date of spraying (June 3) many of the wild oat plants were in the 3 and 3½ leaf stage.. Barban was applied at rates of 4, 8, and 16 oz/A with a sprayer equipped with hollow cone nozzles (Y-4) delivering 10 U.S. gallons per acre at 45 psi.

Excellent control of wild oats was obtained at all dates of spraying with the exception of dates 1 to 3 (0-3 days after emergence). Only partial control was achieved when spraying from 1 to 3 days after emergence. There was no significant difference in wild oat control between rates of spraying, i.e. the 4 oz/A were equally as effective as 8 and 16 oz/A.

Considerable injury to Selkirk wheat occurred in plots treated with 1 lb/A. Injury was most severe as a result of spraying at stages 7 to 10 (11-15 days after emergence of the wheat) with reductions in stand of 80 to 90 per cent recorded in the 1 lb/A plots. The 4 and 8 oz/A rates of barban did not result in serious injury to the wheat except at the last date of spraying.

On the basis of these results it would appear that the period during which barban can be applied can be broadened somewhat over the 4 to 9 days after emergence period recommended for 1960. It would also appear that Selkirk wheat is not sufficiently tolerant to barban to permit treatment with 1 lb/A. Some refinements in the barban recommendations for 1961 may be necessary.

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FACTORS INFLUENCING WILD OAT CONTROL WITH BARBAN

Otto L. Hoffman, P. W. Gull, Harry C. Zeisig and Jean R. Epperly[1]

As much as a fourfold increase in the activity of barban (Carbyne) has been obtained by changing application techniques. Higher pressures and smaller aperture nozzles tend to give improved performance. It is probable that this improved performance is due to better deposition of spray droplets near the base of the first leaf blade and on the leaf sheath. These two areas respond to lower levels of applied barban than does the leaf tip. The higher activity of the basal portion of the plant is probably due to the slow transport of the active factor to the growing tip. Transport from the leaf to the growing point requires between 2 to 3 days.

Field data for any one experiment may fail to confirm the effects of nozzle aperture, spray pressures or other conditions because of (1) the low contribution of each factor in some tests or (2) the data to not cover a wide enough dosage range. The dosage response curve for barban may be very steep at times. Over a series of experiments it has been found that from practically no wild oat control to practically total control requires only a two- to fourfold increase in rate.

In three comparisons between ground and air application it was observed that wild oat control was slightly better with the ground equipment. MCPA can be used with barban applications as a tank mix without significantly reducing barban activity if no more of the MCPA is used than of the barban. When larger amounts of MCPA are used the activity of barban may be reduced.

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PLACEMENT OF HERBICIDE AS IT AFFECTS THE CONTROL OF WILD OATS WITH 2,3-DICHLOROALLYL DIISOPROPYLTHIOLCARBAMATE

H. A. Friesen and D. R. Walker[1]

Acceptable control of wild oats in flax and barley with pre-planting treatments of 2,3-dichloroallyl diisopropylthiolcarbamate (Avadex) has been obtained quite consistently by a number of workers (2, 4, and 5).

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In these tests, acceptable control usually implied a reduction in the numbers of wild oats plants of 85 percent or more at dosages of 1.5 to 2.0 lb/A. However, in a few of the trials rather wide deviations from this norm were recorded. Failure to obtain better than 70 percent reduction in plant numbers in a field trial at Lacombe[2], where the wild oats were known to have been seeded very deeply, suggested that seeds which germinated below the treated layer of soil were capable of growing through it unharmed. Consequently, a number of experiments were conducted in the summer and fall of 1960 to learn the possible effects of the placement of the herbicide in the soil relative to the location of the seed.

As a preliminary step 100 surviving wild oats plants were pulled from each of a number of test plots which had been treated with this herbicide at Lacombe in 1960 and the length of the internode from the seed to the crown was measured. In 68 percent of the pulled plants the internode length was greater than the likely depth of the herbicide incorporation, in 20 percent the length of internode and depth of incorporation were closely similar while in the remaining 12 percent the seed and the crown were at the same depth, namely at the soil surface. While these results lent some support to the earlier observation[2] they did not fully account for all of the "escapes" or surviving wild oats plants.

In closely controlled experiments conducted in growth cabinets, wild oats were planted:

(a) 2 inches deep in untreated soil and just before emergence were covered with a 2 inch layer of treated soil.

(b) 2 inches deep in treated soil and just before emergence were covered with a further 2 inch layer of treated soil.

(c) 1 inch deep in 2 inches of untreated soil overlying treated soil.

In all experiments the herbicide was sprayed at 0.5, 1.0 and 1.5 lb/A on a two inch thickness of soil and thoroughly mixed. All treatments were conducted on three soil types selected on the basis of texture: fine sandy loam, loam, and silty clay loam (poor structure).

In treatment (b) none of the wild oats which germinated in the 2 inches of treated soil and were forced to grow through a further 2-inch layer of treated soil survived, regardless of dosage of herbicide or type of soil used. In marked contrast, about one-half of the seeds which germinated in a similar depth of untreated soil [treatment (a)] were able to grow through a 2-inch layer of soil treated with 0.5 lb/A of the chemical and survive. There were surviving plants at the two higher rates although their numbers were greatly reduced. In treatment (c) there was no apparent effect when only the roots of the wild oats were in contact with treated soil. Thus, all seeds planted in untreated soil 1 inch above soil treated with 0.5, 1.0 and 1.5 lb/A. of the herbicide survived.

These experiments established quite conclusively that 2,3-dichloroallyl diisopropylthiolcarbamate is effective only when the coleoptile of wild oats comes into contact with treated soil. No harmful effects were noted in these studies where only the roots were in contact with the treated soils.

Further evidence to support this conclusion came from a separate experiment (actually intended to study breakdown in the soil) in which the wild oats seeds were planted in an upright position with the embryos into the soil and the tips of the seeds protruding above the surface. The dosages of herbicide used were 1.0 and 2.0 lb/A, well mixed with the soil. At 1.0 lb/A there was almost complete survival while at 2.0 lb/A less than 50 percent of the wild oats survived. These results suggest several possibilities, viz: 1) the hull protected the coleoptile until it emerged, 2) the length of time that the coleoptile was in contact with the soil solution was not sufficient and 3) the coleoptile was not sensitive to the herbicide at this stage. Further studies, now in progress should establish the relative importance of these factors.

The observation that some wild oats survived after germinating in and passing through a 1-inch layer of untreated soil before passing through a further 2-inch layer of treated soil, indicated that the time or stage of development of the coleoptile itself influenced the effectiveness of the herbicide. While this effect was largely overcome by increasing the concentration of the herbicide in the treated layer of soil it has much practical significance because field equipment does not incorporate the herbicide nearly as uniformly as it was done in the laboratory. Concentration of the herbicide in soil could also be affected by movement with the soil water and by soil micro-organisms. Preliminary field observations indicate that the herbicide is not readily moved by soil water and has a relatively long life in the soil. Intensive laboratory studies presently underway suggest that the herbicide is adsorbed strongly to organic matter since it was moved by 10 inches of water (under suction) in washed sand. Breakdown following incubation for one month of treated sterilized and unsterilized soils has been observed and may be due to micro-organisms. Further, study of these latter aspects is required to better establish their influence on the behavior of this herbicide.

[1] Contributed by Research Branch, Canada Dept. of Agriculture, Lacombe, Alta.

[2] Friesen, H. A. The control of wild oats with 2, 3-dichloroallyl diisopropylthiolcarbamate (Avadex) in wheat and barley sown on summerfallow. Res. Rpt. Nat. Weed Comm. (Western Canada Section), 1960, p. 33.

FARMER ACCEPTANCE OF TWO NEW SELECTIVE HERBICIDES FOR WILD OATS

T. V. Beck [1]

Wild oats has been particularly serious in Western Canada. Hundreds of herbicides have been tested over the past ten years and in 1959 two herbicides were recommended for wild oat control in cereal crops.

The herbicides differ in method of application, mode of action and the manner in which they were marketed this year, but one acceptance problem common to both was their cost as compared to that of most herbicides now in use by the grain farmer. This high cost coupled with the generally depressed financial condition of the farming economy had considerable effect on their use this year. Both herbicides have two distinct advantages which were not enjoyed by 2,4-D when it was introduced Firstly, farm sprayers are now readily available and secondly, farmers are now familiar with the general advantages and principles of chemical weed control.

Each chemical has its own specific peculiarities, limitations or application problems which must be accepted by the farmer. The final acceptance of the chemical will be based on the results as compared to these specific problems.

2,3-Dichloroallyl diisopropylthiolcarbamate (Avadex) was recommended for use on flax and for trial use on barley, rapeseed, sugar beets and sunflowers. The herbicide is sprayed on the soil surface before seeding. It is immediately incorporated with the top two or three inches of soil prior to, or during the seeding operation. It then kills germinating wild oats for a period up to eight weeks. Sufficient material was placed on the market this year so that there was no shortage.

This herbicide involves the pre-planting principle of application which is completely new to most farmers. It also requires the spraying of land with relatively large volumes of water and may necessitate an extra tillage operation, both done at a time when the farmer is especially busy. It must be applied in anticipation of wild oats growth rather than those already growing and only when conditions permit thorough mixing.

One advantage of the herbicide is that it eliminates the necessity of delayed seeding but where seeding is delayed by weather conditions the necessity of using the herbicide is decreased. Other advantages are the

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long period of control afforded, the fact that little moisture is used by wild oats and that damage by post-emergence spraying machinery is eliminated.

Despite any disadvantages and limitations, the herbicide was well accepted in wild oat infested areas of the prairie provinces this year where it is estimated that well over 70,000 acres was sprayed. This is over 15 times the acreage sprayed with 2,4-D in its introductory year. The majority of this was used on flax, but a fair percentage has been used on rapeseed and sugar beets. A limited amount has been applied on sunflowers, potatoes and soybeans.

Barban (Carbyne, 4-chloro-2-butynyl *N*-(3-chlorophenyl)carbamate) was recommended for trial use in wheat, barley, rapeseed and sugar beets. It is a post-emergence herbicide applied when the wild oats are in the two to three leaf stage, about four to nine days after emergence of the wild oats. An ordinary farm sprayer is used, applying five gallons of water per acre.

Wild oats, when sprayed at the proper stage become stunted, stop growing, and eventually die. A few may recover and develop stunted tillers and small heads. Where the crop is vigorous these should not prove troublesome.

Problems confronting the acceptance of this herbicide are the critical timing necessary in its application, the dependence on the uniformity of the wild oats at the time of application and the fact that wild oats are stunted, rather than killed immediately. Further, the herbicide is applied at a very busy time of the year and post-emergence spraying may mean wheel damage.

The herbicide has the advantage of being applied as a post-emergence spray making it necessary to treat only infested areas.

This herbicide was marketed on a limited basis to confirm its value under farm use, thus it is difficult to determine what the acceptance of the chemical would be it it had been freely marketed. Even though these tests were reasonably costly and generally limited to 10 acres, an estimated 16,000 acres were treated in Western Canada. Compared to an estimated 2,4-D figure of 5,000 acres in 1946, this would appear to be very favourable acceptance.

It thus appears that the herbicides have been well accepted. Acreages treated compare favourably with those treated with 2,4-D in its introductory year. Sufficient of each material has been sold to provide a good distribution of practical farm demonstrations. Results appear to have satisfied the users. Recent research has shown that lower rates will give satisfactory control thus reducing costs. It thus appears that those herbicides have successfully completed the first steps toward general acceptance in the wild oat infested areas of Western Canada.

[1] Weed Control Specialist, Saskatchewan Department of Agriculture.

PRE-EMERGENCE CRABGRASS TRIALS—1960

R. J. Otten and J. E. Gallagher [1]

Tests in the Amchem greenhouses during the winter of 1959-1960 indicated that several new organic arsenicals had the property of selective pre-emergence crabgrass control; that is, preventing crabgrass seeds from growing past the seedling stage while permitting turfgrass seed to sprout and grow normally.

Outdoor tests performed during the spring and summer of 1960 were designed to test these organic arsenicals and other herbicides under field conditions. The objectives of these tests were three-fold; (1) to determine the effectiveness of these herbicides as single application pre-emergence crabgrass control herbicides; (2) to determine tolerance of turfgrasses planted immediately or at intervals after application of the herbicide; (3) to determine the tolerance of turfgrass seedlings to applications of the herbicide at different stages of growth.

The pre-emergence crabgrass trials were conducted at a nearby golf course. The turfgrass population was a mixture of Kentucky bluegrass, fescue, and bentgrass. Standard experimental techniques were followed with plots 6′ x 10′ replicated three times and randomized. The materials reported here are taken from a total of 27 different herbicides. Those not mentioned were experimental and not satisfactory. Of the materials reported some are commercially available as products, others are experimental formulas.

Of the products tested, two formulations of tricalcium arsenate, one containing 2,4-D and 2,4,5-TP, applied at a rate of 10 lb 85% tricalcium arsenate showed 75% control and the other 24% control at the end of the season. Two commercial formulations of chlordane did not provide control at any time during the season. The commercial formulation of dimethyl 2,3,5,6-tetrachloroterephthalate (Dacthal) produced excellent crabgrass control which lasted throughout the season.

Of the experimental formulations tested 2,3,5,6-tetrachloroterephthalate (DAC 893) and *O*-2,4-dichlorophenyl *O*-methyl isopropylphosphoramidothioate (Zytron M-1481 and M-1329) in this test provided satisfactory crabgrass control. The liquid appeared to be slightly superior to the vermiculite formulation. Of the Amchem experimental formulations, XF 832 (calcium propyl arsenate) provided adequate crabgrass control throughout the season.

Seed tolerance trials: Plots 6′ x 20′ were laid out in a newly fitted area. Dry and liquid pre-emergence herbicides were applied as in the pre-emergence trials. One foot rows of bentgrass, bluegrass, fescue, ryegrass and clover were seeded the following day and at intervals of one, two and four weeks following application of the herbicides. Half of each plot was raked lightly before and after seeding. No mulch was used but irrigation was used as needed to keep the soil surface moist.

Of the materials used XF 832 and chlordane produced no significant reduction in the stand of turfgrasses at any date of seeding.

Zytron and DAC 893 inhibited all grasses except for a slight stand of ryegrass up to four weeks after application of the herbicide.

Tricalcium arsenate + 2,4-D and 2,4,5-TP reduced the germination of all grasses planted up to four weeks after treatment. Unexpectedly, bentgrass grew better than any other species.

Seedling tolerance trials: Strips 5′ x 100′ were seeded to pure stands of Seaside bentgrass, Kentucky bluegrass, chewings fescue, perennial ryegrass, White Dutch clover and smooth crabgrass. At two intervals after germination, 18-inch bands of the same herbicides were applied across these seedling grass strips. No mulch was used but irrigation was available to provide adequate moisture.

XF 832 did not affect bent, bluegrass or ryegrass at rates of ¾ or 1½ lb/1000 sq. ft. at 3 or 6 weeks after seeding. Fescue and clover were injured slightly at both rates. While this herbicide was intended for use pre-emergence, it caused a significant reduction in the stand of crabgrass when applied post-emergence to crabgrass in the 2 leaf stage. Control was almost complete at the 1½ lb rate.

Zytron M-1329 and M-1481: The dry formulation M-1481 produced slight injury to bent, bluegrass and fescue, while the liquid M-1329 caused considerable injury to these same species.

Chlordane: This material produced no significant injury on seedling turfgrasses or clover.

DAC 893: This material produced only slight injury, most of it in the early treatment.

Tricalcium arsenate plus 2,4-D and 2,4,5-TP produced significant discoloration and stand reduction of all turfgrasses as well as crabgrass.

Based on 1960 field tests it is apparent that XF 832 (calcium propyl arsonate) within the range of rates tested most nearly satisfied the objective stated at the beginning of this paper.

Zytron and Dacthal, while offering excellent pre-emergence crabgrass control and satisfactory turfgrass

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tolerance, have the disadvantage of preventing growth of turfgrass seeds planted within four weeks after application of these chemicals.

[1] Amchem Products, Inc., Ambler, Pennsylvania

SILVEX FOR CHICKWEED IN TURF

W. D. Smith [1]

Experiments were conducted to determine (1) the rate of silvex needed to control mouse-ear chickweed and common chickweed in turf, (2) the effect of silvex on common turf grasses, and (3) the residual of silvex in soil. Triplicate plots were treated with silvex at 1, 1.6 and 2 lb/A, in water at 92 gpa, in each experiment. One-half of each plot was re-treated three weeks after each initial application.

Mouse-ear chickweed growing in turf was treated with silvex on June 17, August 3, October 15, December 3, 1959, June 30, 1960 and in non-turf on April 22 and June 14, 1960.

Excellent control, 90-100 percent reduction in stand, of mouse-ear chickweed was obtained in plots treated with single applications of silvex at 1, 1.6 and 2 lb/A on June 17, August 3, October 15 and December 3, 1959, and at 2 lb/A on June 14 and June 30, 1960 (Table 1). Excellent control was also obtained with two applications of silvex on October 15 (except plots treated with silvex at 1.6 lb/A) and December 3, 1959, and on April 22 and June 30, 1960. The other treatments did not give satisfactory control. The reason for the poor control with silvex at 1.6 lb/A on October 15 was not determined.

Table 1. Percent control of mouse-ear chickweed with silvex.

Application date	Observation date	Rate lb/A	Chickweed control pct 1 Appl	Chickweed control pct 2 Appl	Reduction * in check pct
Growing in turf					
6-17-59	7- 8-59	1.0	100	—	
		1.6	100	—	
		2.0	100	—	
		Check			56
8- 3-59	8-25-59	1.0	94	—	
		1.6	98	—	
		2.0	100	—	
		Check			36
10-15-59	5- 4-60	1.0	100	100	
		1.6	100	50	
		2.0	100	100	
		Check			31
12- 3-59	5- 4-60	1.0	90	94	
		1.6	100	100	
		2.0	100	100	
		Check			47
6-30-60	8-10-60	1.0	80	94	
		1.6	79	100	
		2.0	100	100	
		Check			0
Growing in non-turf areas					
4-22-60	7- 6-60	1.0	40	98	
		1.6	64	100	
		2.0	58	100	
		Check			48
6-14-60	7- 1-60	1.0	82	—	
		1.6	80	—	
		2.0	91	—	
		Check			55

* Reduction due to unfavorable growing conditions.

Common chickweed was treated with silvex at 1, 1.6 and 2 lb/A on June 23, August 11 and October 16, 1959, and on April 8, June 21, July 15, and October 20, 1960. One application, regardless of rate, gave excellent control.

Silvex at 1, 1.6 and 2 lb/A was applied on five different species of turf grass on April 14, July 7, and October 12, 1960. One-half of each plot was re-treated 3 weeks after the initial application.

Table 2. Maximum percent discoloration of five turf grasses following treatment with silvex.

Application date	% Discoloration of Turf 1 lb/A 1 Appl	1 lb/A 2 Appl	1.6 lb/A 1 Appl	1.6 lb/A 2 Appl	2 lb/A 1 Appl	2 lb/A 2 Appl
Colonial Bentgrass						
4-14-60	3	12	5	17	3	28
7- 7-60	65	75	75	80	80	92
10-12-60	42	45	63	63	73	73
Highland Bentgrass						
4-14-60	10	23	12	32	10	40
7- 7-60	58	75	70	85	78	80
10-12-60	53	57	50	60	50	65
Common Kentucky Bluegrass						
4-14-60	18	27	33	43	40	47
7- 7-60	17	17	27	40	20	50
10-12-60	5	7	7	17	8	20
Merion Kentucky Bluegrass						
4-14-60	22	32	30	40	27	42
7- 7-60	37	15	48	25	57	33
10-12-60	13	17	22	30	25	33
Chewings Fescue						
4-14-60	5	—	20	—	17	—
7- 7-60	32	20	47	28	60	15
10-12-60	17	23	30	27	20	28

All the turf grasses were discolored somewhat following treatment with silvex (Table 2). Most severe foliage discoloration occurred in the Colonial bentgrass and Highland bentgrass plots. Slight to considerable reduction in stand occurred in the bentgrass plots that showed 50 percent or more discoloration. The remaining plants recovered, usually within five weeks. Common Kentucky bluegrass, Merion Kentucky bluegrass and Chewings fescue recovered, usually within 3 to 5 weeks, with no reduction in stand.

In the residual experiment, silvex was applied to soil on April 18, July 30, and September 19, 1960. One-half of each plot was re-treated 3 weeks after the initial application. Soil samples in the 0- to 3-inch level in each plot were taken at weekly intervals for four weeks following both one and two applications. Red kidney beans and Merion Kentucky bluegrass were planted in the soil samples and the germination recorded. Both beans and bluegrass showed a slight decrease in percent of germination when planted in the soil taken from plots on which silvex was applied one week earlier. Little or no reduction in germination occurred in the soil samples taken after the first week. However, stunting and growth abnormalities occurred in all the beans planted in the soil samples taken one through four weeks following both one and two applications of silvex.

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CONTROL OF SEEDLING GRASSES IN TURF WITH DIPHENYLACETONITRILE AND A SUBSTITUTED DINITROANILINE

E. F. Alder, W. L. Wright, and Q. F. Soper[1]

Over the course of two seasons a total of 32 turf field tests containing over 1500 plots were conducted in order to evaluate two herbicidal materials for their selective action against seedling grasses in turf. The first of these

materials is diphenylacetonitrile which was coded as L-13489 and now has the tentative generic name diphenatrile. The second is *N,N*- di(*n*-propyl)-2,6-dinitroaniline which was coded as L-31864.

Field tests were placed in areas known to be heavily infested with seedling weed grasses the preceding year. Smooth crabgrass was the dominant weed grass in most plots. Large crabgrass, yellow and green foxtails and goosegrass were present in several of the plots. In each test all treatments were replicated four times in a randomized block design. Turf plots were four by six feet. Two-foot buffers were left between plots and four-foot buffers between replications. The seedling grasses in four foot-square quadrats in each plot of the four replications were counted and averaged. In test areas of low weed grass infestation, entire plot counts were made. The final count was taken 60-100 days after treatment in the first of the test seasons, and 120-140 days after treatment in the second test season.

During the first test season diphenatrile was tested at 8, 16, and 32 lb/A. The average control in all tests was 7 percent at 16 lb/A and 95 percent at 32 lb/A. Applications made in the fall showed very little activity the following season, even at rates as high as 48 lb/A. In the spring of the second test season applications were made at 20, 30, 40, and 50 lb/A on turf of widely different quality and with light to extremely heavy seedling grass infestations. At 20 lb/A an average control from all tests of 95 percent was obtained. Ninety-eight percent was obtained at 30 lb/A and higher. Control of seedling weed grasses at the recommended rate of 30 lb/A was effected for a period of 120-140 days. It was possible, however, to seed turf grasses successfully 86 days after treatment. There was no damage to any of the established turfs tested—even at greatly elevated rates.

Diphenatrile is an extremely safe material. It has an acute oral LD_{50} in mice of greater than 3500 mg/kg. It has not caused dermal irritation and possesses no unpleasant odor. The unique selectivity against seedling grasses and safety to broadleaf plants makes it possible to use the material as a seedling grass herbicide in flower beds, shrubbery plantings, and broadleaf ground cover, as well as in turf.

Study of the general herbicidal activity of a series of unsubstituted dinitroanilines revealed that the 2,6-dinitro-compound was markedly more active than the 2,4-dinitro-, which was, in turn, more active than the 2,3-dinitroaniline. When dialkyl substitutions were made on the amino group of the 2,6-dinitro molecule, the resultant compounds lost general herbicidal properties, but became highly selective against seedling grasses in pre-emergence applications. The di-*n*-propyl has proved to be the most active dialkyl substitution. Activity can be further increased by appropriate substitutions in the 4-position of the ring. The herbicidal order of activity of the 4-position substituents has been determined as $CF_3 > CH_3 > Cl > H$. The 4-CF_3 (L-36352) has been given the tentative generic name trifluralin. The 4-CH_3 (L-35455) bears the tentative generic name of dipropalin. The 4-Cl is still coded as L-34906 and the unsubstituted hydrogen compound is the parent L-31864.

Extensive field testing of L-31864 was conducted under a wide variety of turf conditions, and the material was found to be highly active against seedling grasses. Average seedling grass control in all tests was 86 percent at 2.5 lb/A, 93 percent at 5 lb/A, and 96 percent or better at 10 lb/A. There was no evidence of damage on any of the turfs tested. For 120-140 day control of seedling grasses, it would appear that 7-8 lb/A is sufficient. Granular formulations were found to provide slightly longer control than emulsifiable sprays. L-31864 is somewhat less selective than diphenatrile in that it does show some pre-emergence activity on certain broadleaf species.

Greenhouse and limited field tests have shown that trifluralin and dipropalin possess the same selectivity as L-31864. Their greater activity makes it appear that these two compounds are the most active seedling grass turf herbicides yet described, with perhaps 4 to 5 lb/A sufficient for full-season control. An intensive evaluation program on these two materials is now under way.

[1] Eli Lilly and Co., Greenfield Laboratories, Greenfield, Indiana.

PROGRESS REPORT ON CONTROL OF CRABGRASS IN ESTABLISHED TURF WITH DIMETHYL 2,3,5,6-TETRACHLOROTEREPHTHALATE

H. H. Harris[1]

There has been a marked increase in interest in and use of pre-emergence herbicides for the control of crabgrass in turf the past few years. It would seem logical to use a method to prevent crabgrass from being a competitor, rather than to attempt its removal after it is in competition with the turf grasses. One must realize, though, that the use of a herbicide in crabgrass control is just one of the tools a home-owner has available toward obtaining and maintaining the much desired luxuriant lawn. The use of a pre-emergence crabgrass herbicide should be followed up with a suitable program that will provide proper fertilization, mowing, watering and other practices so important for production of a good turf.

Tests by Diamond personnel and a limited number of experiment station cooperators in previous years have demonstrated the utility of dimethyl 2,3,5,6-tetrachloroterephthalate (Dacthal)® for control of crabgrass in established turf. Ten tests were conducted at Painesville, Ohio this season, and some of these findings will be reported here. In most tests three or four replicates of 10' x 10' plots were utilized. It was found that this plot size made for easier evaluation of infestations, especially when control estimates were based on area covered by crabgrass.

With sprays the required amount of material was mixed with water and applied with a knapsack sprayer with two TeeJet nozzles on a boom to individual plots at the rate of 200 gal/A. Granular formulations were applied with a Scotts spreader. An excess above the required amount of a granular formulation was put in the spreader and then, after application to each plot, the remainder was re-weighed. Any amount needed to bring it up to the prescribed rate was sprinkled on, using a jar with a perforated cap. With both sprays and granulars, application was made in two right-angle directions to obtain uniform coverage.

Two of these tests at Painesville included a comparison of the wettable powder with a 20/40 mesh fast-disintegrating 1½ percent granular formulation and a 20/40 mesh slow-disintegrating 1½ percent granular formulation at 10 and 5 lb/A rates. Results from these two Painesville tests, applied April 25 and 27 respectively, have been averaged and are given in Table 1. The early season observations were made the latter part of July, with the late observations on August 29 and September 29. Percent control is based on area covered with crabgrass in comparison with untreated check plots.

Table 1. Relative Effectiveness of Certain Dacthal Formulations in Control of Crabgrass in Turf—1960.

Formulation	lb/A	Percent crabgrass control	
		Early observation	Late observation
Wettable powder	5	96	88
Wettable powder	10	99	98
20/40 Fast granular	5	99	91
20/40 Fast granular	10	100	99
20/40 Slow granular	5	96	77
20/40 Slow granular	10	100	94
Check plots (percent area covered)		42	62

Generally good control of crabgrass was obtained with Dacthal at the 5 lb/A rate into July, but by late August the control at this rate was definitely inferior. The results confirm previous findings and suggestions that a minimum of 10 lb/A should be used for seasonal control of crabgrass. The control obtained with the wettable powder approximated that of the fast-disintegrating granular formulation, with the slow-disintegrating granules being possibly slightly less effective. No adverse effect of Dacthal on turf grasses was noted in these tests.

Information still points to the necessity of making Dacthal application prior to germination of crabgrass seeds. In the Painesville area crabgrass emergence this year coincided with the time forsythia blossoms started to fall.

Toxicological tests by a private laboratory show Dacthal to be non-toxic to goldfish and bluegills. Thus, there should not be any danger where some Dacthal might get washed from lawns into fish ponds. The tests indicate a low order of mammalian toxicity. This should make Dacthal suitable for application to home lawns, where children might accidentally come into contact with it. Also, it has not been found odoriferous or unpleasant to apply.

The results again point out the utility of Dacthal, for crabgrass control, applied in a uniform manner in the spring to established turf at a minimum rate of 10 lb/A, prior to crabgrass seed germination.

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ARSENIC TOXICITY — CURRENT PROGRESS

W. H. Daniel[1]

Several of the compounds being offered for weedy grass control in turf are carrying arsenic. There is one basic point in its successful performance—in some way sufficient arsenic must get into the plant to stop its normal carbohydrate transfer. Studies in plant physiology indicate that the Krebs cycle is affected. Visual observations show that the arsenic accumulates, or affects first those cells which are dividing. The organic arsenics may be picked up by leaf or roots. High concentrations of arsenic in the rootzone may favor root pickup.

Generally many are acquainted with arsenic toxicity achieved by foliar burning with compounds such as sodium arsenite. Since 1954 the use of DSMA and AMA have become the preferred materials for crabgrass killing when applied as two applications 5 to 7 days apart. In this case there is sufficient foliage absorption to produce toxicity.

The absorption of arsenic by rootzones becomes the key to this discussion. The comparative size of phosphorus and arsenic ions makes it possible for the root to pick up either, depending upon their mass action, but once inside the plant the arsenic toxicity shows on the seedling plant as a cessation or kill, a loss of chlorophyll, a cessation of root growth, and under adversity death of the young seedling.

Several cases have been reported where, although arsenic applications have been made under standard conditions, a followup use of a phosphorus carrying fertilizer, or applying large amounts of phosphorus-carrying dry fertilizer, overrode the anticipated arsenic toxicity so that crabgrass plants regained normal vigor and growth. Perhaps better said, arsenic toxicity is basically phosphorus starvation within the plant.

We began testing arsenics in our turf research program at Purdue University in 1951. Since that time over 60 compounds have been tested from more than ten sources. The trend has been toward developing organic arsenicals for soil or pre-emergence applications which would give maximum selectivity between species. Considerable success was achieved with calcium methyl arsonate at 3 lb per 1,000 sq ft. However, production cost was not favorable.

Currently calcium propyl arsonate, carrying the experimental No. AMA-41 from Vineland Chemical Company, offers the most selectivity observed between seedlings of desired grasses; namely, bluegrass and bent, and undesired grasses; namely, smooth and hairy crabgrass. Recommendations of 1.5 to 2 lb active ingredient per 1,000 sq ft appear ample. These products seem to have only one season residual, maybe less. They do offer the possibility of killing crabgrass at any stage, and may be particularly adapted for use in markets where the time of crabgrass germination may be somewhat delayed and calendar dates on labels become a problem.

There is one point of concern to weed control workers. We have very isolated, but very definite, cases where calcium arsenate was applied in proper form, rate and amounts. Subsequently the ground froze with high amounts of water in the soil, then the arsenic was dissolved by moisture being present, such as melting snow, but it was subsequently intensely concentrated by severe freezing weather which caused ice crystallization. Under these conditions areas in Wisconsin, Chicago, Massachusetts, New Jersey have had damage. This occurs as a severe burn of foliage showing immediately after the snow melts, closely tied to application pattern, and most severe where the ground is most frozen. The same thing has been observed with just 10-3-7 fertilizer which proves the wetting and severe concentration by freezing was necessary.

Based on our observations, we are discouraging the use of any soluble material without its fixing onto the soil without watering at or during winter season. In fact, we also discourage fertilizer use which might result in the same soluble condition. There is considerable merit in the use of arsenic for it has the possibility of restricting the growth of existing *Poa annua*, as well as preventing the survival of several germinating weedy grasses. Our standard rate is 12 lb calcium arsenate, 1.5 lb of calcium propyl arsonate.

Many advances are being made and will continue to be made in weedy grass control, as was pointed out by Gallagher—few packages say this product will grow grass.

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USE OF ATRAZINE TO CONTROL QUACKGRASS IN CORN FIELDS

K. P. Buchholtz[1]

Triazine herbicides were first used experimentally in Wisconsin to control quackgrass in 1957. Initial results were promising and the work has been expanded to include many of the variables that may influence the results obtained. In many instances virtually complete control of the weed has been obtained after treatment. Corn crops planted on treated areas have shown no evidence of injury and have yielded substantially more than on untreated areas.

The usual procedure was to treat quackgrass infested areas in the fall or in the early spring. Treated areas were left undisturbed until just before corn planting time when they were plowed, the soil prepared, and the corn planted. Experimental areas were treated with diuron at 2 pounds per acre immediately after planting to control annual weeds. None of the plots were cultivated during the season. Approximately 2 months after plowing the regrowth of quackgrass was harvested in quadrats in each plot and dry weights obtained. The corn was harvested at maturity. Experimental areas were located on silt loam soils of the Waupun or Miami series.

After treatment with atrazine the quackgrass foliage turned yellow but growth continued. The killing action was slow and maximum effects were not noted until a

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month or more after the corn had been planted. Yields of quackgrass shoot regrowth gave a good measure of the control obtained. Corn yields were correlated negatively with yields of quackgrass regrowth and also gave a good measure of the control obtained.

Initially simazine was used and favorable responses obtained at application rates of 4 and 8 lb/A. Subsequently atrazine was found to be somewhat more effective, particularly when rates as low as 2 lb/A were used and when the applications were made in the spring. A limited number of trials with propazine and with 2-chloro-4-methylamino-6-isopropylamino-*s*-triazine showed them to be effective when applied at 4 and 8 pounds per acre. Work with prometone was discontinued because injury to the corn resulted from the residue of the chemical in the soil. Simetone and 2-methoxy-4-methylamino-6-isopropylamino-*s*-triazine were found to be less effective than atrazine at rates of 2 lb/A.

Applications of atrazine in either the fall or in the spring prior to plowing were markedly superior to applications made after plowing and planting the corn in the spring. Early spring applications were more effective than fall treatments, particularly when low rates were used. Applications made in the early spring were somewhat better than treatments made just prior to planting the corn.

Better kills of quackgrass were obtained when treated areas received applications of nitrogen containing fertilizer. The beneficial effects of nitrogen fertilizer were most noticeable when atrazine was applied at 1 or 2 pounds per acre. The effect appears to be related to the increased rate of carbohydrate reserve depletion that occurs when the growth of the weed is stimulated by nitrogen applications.

Applications of 2 lb/A of atrazine have given effective control of quackgrass when they were made in the early spring and when they were combined with nitrogen fertilization. Use of 4 lb/A has given virtually complete control of the weed but has not commonly resulted in increased yield of corn over plots treated at 2 lb/A. Treatment with 1 lb/A has given some control under favorable conditions but corn yields have remained depressed. Areas treated with atrazine at 2 lb/A have not retained sufficient residue in the soil to injure oats planted 12 months later. Areas treated with 4 lb/A have sometimes been toxic to oats the next year. Crops other than corn should not be planted on treated areas during the first year after treatment because of probable injury.

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PRE-EMERGENCE WEED CONTROL IN GRAIN SORGHUM[1]

W. M. Phillips[2]

Sorghum is susceptible to infestation by a variety of broadleaved and grassy weeds. Detrimental effects of weeds, particularly in dry seasons, makes early weed control desirable.

Several herbicides were evaluated for pre-emergence weed control in grain sorghum from 1957 to 1960. Climatic conditions favored high crop yields throughout the four years, but dry periods at planting time caused variable emergence of weeds, and affected the action of the herbicides.

Studies were conducted on field plantings of the variety Midland and on RS-610 hybrid grain sorghum. All treatments were applied as water mixed sprays at a total volume of 40 gpa. Untreated and weed-free checks were included in each experiment.

Simazine was applied in four experiments from 1957 to 1959. This herbicide resulted in satisfactory weed control when applied at rates of 2 lb/A or more. 4 lb/A significantly reduced yields in 3 out of 4 experiments, 2 lb/A reduced yields in two experiments. Thus it appears that, when used at rates necessary for weed control, simazine often damages the crop.

Propazine was used in each of the four years. In no case did the 4 lb/A rate cause a significant reduction. In one of two 1958 experiments yields from the 2 lb/A treatment were low. This yield reduction appeared to be due to poor weed control following uneven application, rather than chemical effect on the crop. In all other studies propazine at 2 lb/A or more resulted in good weed control, and in 1960 1 lb/A was satisfactory.

Several other triazine compounds were included in one or more experiments. Among those evaluated were trietazine, atrazine, ipazine, simetone, and 2-chloro-4-isopropylamino-6-methylamino-*s*-triazine. None of these materials appeared to be superior to propazine when applied pre-emergence. In 1960 atrazine was used as an early post-emergence spray at 1, 2 and 4 lb/A. Based on one study, this treatment appeared promising and warrants additional testing. Pre-emergence applications of atrazine damaged the crop in 1960.

When applied at rates necessary for weed control, pre-emergence treatments with 2,4-D nearly always damaged the crop.

Several substituted benzoic acids were used during the experimental period. The chloro-substituted materials, PBA and TBA, gave generally satisfactory weed control but caused stunting of the crop. Following reports of lower toxicity to grasses, methyl and methoxy substituted compounds were used in 1960. These materials proved less effective than the chloro-substituted compounds in controlling weedy grasses, but there appeared to be no decrease in toxicity to sorghums.

2,4-DEP was not an effective herbicide at rates up to 6 lb/A.

The value of sorghum weed control was demonstrated by comparing yields of weed free plots with those where weeds not controlled. In three of five experiments the weed free areas yielded substantially more than the weedy plots. The average for all five experiments was 75.2 bu/A and 53.8 bu/A for the weed free and weedy plots respectively. This loss of yield does not, however, reflect the amount which could be saved only with chemical weed control. In most years conventional cultivation equipment could be used to eliminate virtually all significant weed competition.

[1] Cooperative investigations of the Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture and the Kansas Agricultural Experiment Station. Contribution No. 153. Ft. Hays Branch, Kansas Agricultural Experiment Station, Hays, Kansas.

[2] Research Agronomist, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture.

THE COMPETITIVE EFFECTS OF VARIOUS INTENSITIES OF PIGWEED ON THE DEVELOPMENT OF CORN AND SOYBEANS

Moti Kundandas Moolani and F. W. Slife[1]

Weeds bring about yield reductions in crops by competing for moisture, nutrients, and light. Little is known about yield losses resulting from annual weed infestations in inter-tilled field crops such as corn and soybeans. The objective of this present study was to determine the magnitude of yield reductions from varying intensities of pigweed (*Amaranthus hybridus L.*) growing in competition with corn and soybeans and to find out the effect of weed removal on growth and yield of such crops.

Two field experiments with planted stands of pigweed in corn and soybeans were conducted at the Agronomy South Farm at the University of Illinois. In the first experiments, the weeds were allowed to grow to maturity and the growth and yield of corn and soybeans were recorded. The treatments were weeds grown in a

band of 4"—6" width, weeds grown every 1", 5", 10", 20", 40", and check (weed-free). The weeds were grown in the rows with crops and the area between the rows was kept free with mechanical cultivation. The soil was relatively fertile and 80 lb/A of additional nitrogen was applied to all corn plots. In the second experiment, the time of weed removal was studied. Uniform stands of pigweed were established (one weed every one inch) and then were removed at three-week intervals. A randomized block design was used in each experiment and the data obtained was statistically analyzed.

The growth and yield of crops as influenced by various weed infestations were studied and the results so obtained are given in Table 1..

Table 1.—Effect of various intensities of *Amaranthus hybridus* L. on yield of corn and soybeans (average of two years)

Stand of *A. hybridus*	Corn		Soybeans	
	Grain yield bu/acre	*A. hybridus* lb/acre	Grain yield bu/acre	*A. hybridus* lb/acre
Band	64.4	2840	12.6	4290
1"	67.3	2680	14.6	3740
5"	77.6	2060	19.1	3180
10"	90.6	1270	24.9	2560
20"	92.2	940	26.9	2000
40"	101.2	480	31.9	1180
Check	107.5	0	39.9	0

Data from Table 1 show that there was proportionate yield reduction depending on the intensity of weed competition. The corn yield reduction was about 40% if the weeds were allowed to grow in a "band" for the entire season. The same weed infestation reduced soybean yields by about 65%. Such serious yield reduction in soybeans may be due to shading of the bean plants by pigweeds which grew more than twice the height of the bean plants. Dry weight of corn and weeds combined was approximately equal to that of weed-free corn alone but with soybeans, dry weight of crop and weeds combined was about 1½ times that of weed-free soybeans alone.

In the time of weed removal experiment, the results obtained are summarized in Table 2.

Table 2.—Effect of time of weed (*Amaranthus hybridus* L.) removal on yield of corn and soybeans

Time of weed removal	Corn			Soybeans		
	Grain yield bu/acre	Mean yields pct of check	*A. hybridus* lb/acre	Grain yield bu/acre	Mean yields pct of check	*A. hybridus* lb/acre
Check (no weeds)	112.1	100.0	0	33.0	100.0	0
4 weeks	105.3	93.7	290	31.5	95.3	210
7 weeks	104.3	92.8	370	30.0	90.6	410
10 weeks	91.1	81.1	1030	20.0	60.6	1130
13 weeks	85.4	76.0	1380	14.8	44.8	1420
16 weeks	78.9	70.2	1730	13.5	40.8	1900
Weeds not removed	75.2	67.2	1990	11.9	35.8	2260

The results in Table 2 indicate that time of weed removal has a significant influence on growth and yield of corn and soybeans. In corn, the greatest yield reductions occurred when weeds were allowed to grow as long as 10 weeks. At 8 to 10 weeks after planting, corn was in the silk emergence stage. This appears to be a critical stage of corn development insofar as weed competition is concerned. The yield reductions measured at this stage were about 12%, which is more than 1/3 of the total seasonal loss in corn.

In soybeans, yield reductions were more than 50% if weeds are allowed to grow for 10-12 weeks. Such severe effects could be expected from weeds which overtop or seriously shade soybeans.

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FACTORS AFFECTING THE RESPONSE OF FIELD BINDWEED TO 2,4-D[1]

A. F. Wiese and H. E. Rea[2]

Ineffective control of field bindweed with 2,4-D has discouraged farmers and research people since the herbicide became available. In order to gain some insight into this problem, field and laboratory studies have been conducted since 1953 at the Southwestern Great Plains Field Station near Amarillo, Texas. The climate in the area is semi-arid and the average rainfall at the station is 18 inches. The low rainfall combined with low relative humidity and high winds cause frequent periods of drought. The soil type is Pullman silty clay loam.

Field studies have shown that good bindweed control occurs when 2,4-D applications at ½ to 1 lb/A are made to runners that are from 6 to 10 inches long and the top 2 feet of soil is wet. These conditions are most likely to occur about May 20 but may occur at any time during the growing season when a week or more of rainy weather follows a dry period. At equal rates, ester formulations of 2,4-D usually gave more root kill than amine formulations. This was most pronounced as the soil dried and growth conditions were becoming poor. When soil moisture approaches the wilting point 2,4-D will only kill bindweed foliage. Ester formulations of 2,4-D give faster foliage kill than amine formulations. Neither the amount of or constituents in the spray carrier nor the time of day or night at which application was made affected 2,4-D toxicity to bindweed.

Laboratory and greenhouse studies have shown that, with adequate soil moisture, bindweed are most readily injured by 2,4-D if the total carbohydrate content of the leaves is high and in the roots is low. This condition can be brought about by reducing the amount of light or by growing the plants on a soil with low fertility.

[1] Work conducted cooperatively, Tex. Agric. Exp. Sta. and the Soil and Water Conservation Research Division, ARS. USDA. Approved as TAES T.A. 3666.

[2] Agronomist at Bushland and Associate Professor at College Station, Texas.

EXPERIMENTAL APPLICATION OF HERBICIDES IN THE MANAGEMENT OF A WILDLIFE AREA

Ralph B. Hovind[1]

Wildlife habitat needs are specific and management is concerned with the provision of these in the cheapest way possible.

Much is being done now with herbicides in the field including pre-emergence applications in food patches, highland and lowland weed control, roadside and trail brush control, flowage site clearing, wildlife opening creation and maintenance, firebreak sterilizing, ditch maintenance, creation of deer browse, creation of fuel for controlled burning, improvement of species composition in forests to favor wildlife, and the changing of habitat to discourage nuisance wildlife.

I. The growing use is illustrated by work done on the Powell Marsh Wildlife Area in Wisconsin. There iron precipitating bacteria *(Leptothrix* and *Gallionella)* created a nuisance in drainage ditches in a peat bog. Treatment with copper sulfate at 4 PPM alleviated the trouble with no appreciable fish mortality.

II. Control of aquatic and bog plants was necessary. Extensive tests with 2,4-D from 6 to 36 lb/A on leatherleaf showed none was entirely lethal and no increase in effect was shown with higher doses. The same was true for 2,4,5-T. Erbon (Baron) at 13⅓ gal/A of commercial product was unsatisfactory as were four mixtures.

Sedges (mainly *Carex rostratum)* were treated with dalapon from 10-35 lb/A. Anything over 25 lb/A was

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lethal for two seasons. Six chemical mixtures were failures.

Cattails were treated with dalapon at rates of 5-35 lb/A. Used almost full strength in water (5-1) a good kill was obtained at 5 lb/A. Diluted in 100 gallons of water, kills were obtained only after going up to 25 lb/A. Kuron at 1-2 lb/A showed no results. Dalapon as Radapon was tested at 32 and 48 lb/A of commercial product and was lethal.

Phragmites was killed with 42 lb/A of Radapon.

Burreed (emergent) was killed with 12½ lb/A of dalapon.

Sweet fern was killed with 4 lb/A of 2,4-D-2,4,5-T mixture.

Bracken fern was not permanently affected by 4 lb/A of 2,4-D-2,4,5-T mixture.

III. Basin clearing by air application of 2,4-D showed good results (84% kill) with 1½ lb/A in water on aspen, willow and alder. Little effect was noted on resistant hardwoods.

IV. Tests were conducted to see if road and trail brush spraying would hurt seeded clover. No lasting damage was noted.

V. Work on sprays by air to create browse for deer is continuing.

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AQUATIC NUISANCE CONTROL LAWS IN THE NORTH CENTRAL AREA

James H. McDermott[1]

A law can authorize the suppression of aquatic nuisances without giving them specific mention or recognition, and such is the kind of law which, so far as I have been able to determine, is found today in many North Central jurisdictions. The laws of Wisconsin and Michigan deal specifically with the aquatic nuisance problem and its control, while the laws of other jurisdictions in the North Central area do not.

In my limited research on aquatic nuisance control laws in the North Central area, I found it possible to go no further, in most instances, than the water pollution control laws of each jurisdiction. Consequently, I may have overlooked outside the framework of the water pollution control laws—laws which, whether or not they specifically mention aquatic nuisances, provide for their suppression or control.

Of the 17 water pollution control laws studied, only 2—those of Michigan and Wisconsin—specifically refer to such nuisances and authorize their control. The other 15 laws make no specific mention of such nuisances, and in my judgment 2 of such laws do not authorize their control, 7 contain only a doubtful or questionable authorization for such control, and 6 of such laws contain what I would call a probable authorization to suppress aquatic nuisances.

The aquatic nuisance control law enacted by Michigan in 1959 does several important things:

(1) It imposes upon the water resources commission of Michigan the duty, and gives it the power, to "supervise the chemical treatment of the waters of the state for the suppression of swimmers' itch, and other nuisance producing organisms, in accordance with the provisions of this act."

(2) It declares that application of necessary chemicals to waters of Michigan for control of aquatic nuisances is lawful.

(3) It specifies just who may undertake control work under permit from water resources commission,—state, any political subdivision, organized lake or improvement association, property owner, owner's agent, private contractor.

(4) It provides penalties and prosecution by the district attorney of the county wherein violation takes place.

This Michigan law is a good one—concise, clearly worded, and covering all the necessary ground. The penalty provision appears to be a relatively mild one, and I assume it reflects the belief of the Michigan legislature that penalty provisions more severe are unneeded. The attorney general of Michigan apparently has no right under this law to institute a prosecution, this being the job of the local district attorney upon complaint by an authorized agent of the water resources commission. However, under Michigan law the attorney general supervises the work of, consults and advises the prosecuting attorneys of Michigan, so it is clear that in that state the attorney general, if he considers it necessary, can participate very actively in the enforcement of his state's aquatic nuisance control law.

The Wisconsin aquatic nuisance control law was enacted in 1941 as an addition to Sec. 144.53(3), Wis. Stats., and it gives the Wisconsin committee on water pollution the power,—

"To supervise chemical treatment of waters for the suppression of algae, aquatic weeds, swimmers' itch, and other nuisance producing plants and organisms. To this end the committee may conduct experiments for the purpose of ascertaining the best methods of such control. It may purchase equipment and may make a charge for the use of the same and for materials furnished, together with a per diem charge for any services performed in such work. The charge shall be sufficient to reimburse the committee for the use of the equipment, the actual cost of the materials furnished, and the actual cost of the services rendered plus 10 per cent for overhead and development work."

The 1959 Michigan aquatic nuisance law may owe something of its form and content to the Wisconsin law, 20 years old next June. The Michigan law, however, goes further than the older Wisconsin statute in several respects. It specifically provides for supervision of control work by a permit system. The Wisconsin law makes no mention of permits, but the Wisconsin committee on water pollution, through its rules, has established a permit system to effectuate its supervision of aquatic nuisance control. The Michigan law, as already noted, specifies who may engage in control work. The Wisconsin law does not, but the committee on water pollution has cited examples of proper "sponsors" for aquatic nuisance control projects in Rule WP 2.01, which provides that "Sponsors of aquatic nuisance control in accordance with the following procedure: * * *." Other Wisconsin statutes make it clear that cities, villages, towns and town sanitary districts may properly undertake projects to suppress aquatic nuisances, subject, of course, to supervision by the committee on water pollution. See Secs. 62.11(5), 61.34(1), 60.29(29), and 60.306(2), Stats. Still another difference between the statutes is that the Michigan law contains its own penalty and enforcement provision, while the Wisconsin law does not. Violations of the Wisconsin aquatic nuisance control law are punishable under another section of the Wisconsin water pollution control law, namely, Sec. 144.57.

[1] Assistant State Attorney General, Madison, Wisconsin.

AQUATIC WEED CONTROL IN ILLINOIS FARM PONDS

Robert C. Hiltibran[1]

The author and his associates have been engaged in a program of investigations to determine the effect of various chemical preparations on nuisance aquatic weeds found in many bodies of water in central Illinois. Over the past three years 17 preparations have been tried on 20 different kinds of aquatic weeds. Most test plots included about 400 square feet of the vegetation in question.

In June of 1959, coontail, *Ceratophyllum demersum*, was eradicated from test plots by applying a granular preparation of 2-ethyl-hexyl ester of 2,4-D and a liquid preparation of propylene glycol butyl ether esters of silvex, each at a rate of application of 40 ppmw based

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on the free acid equivalent. An application of 10 ppmw granular disodium salt of endothal was very effective.

In June of 1959 six plots of sago pondweed, *Potamogeton pectinatus*, interspersed with a lesser stand of milfoil, *Myriophyllum* sp., located in a farm pond in Lee County were treated with various chemicals. The sago pondweed was cleared from the areas which received an application of 10 ppmw of liquid endothal and 5 ppmw of granular endothal. In July of 1959 eight plots of a dense stand of sago pondweed located in Allerton Lake, 4-H Club Camp Grounds, near Monticello, were treated. Of the areas treated, only those which received liquid or granular endothal were cleared of the sago pondweed. Although the rate in each area was 3 ppmw, the area which was treated with the granular endothal was cleared more rapidly. The other preparations used had no effect. In 1960 an area treated with 2 ppmw of granular endothal was cleared. This work indicates that chemical eradication of sago pondweed, which cannot usually be killed with sodium arsenite, is possible.

Also, during June of 1959, one test plot of curly-leaved pondweed, *P. crispus*, was treated in Mansion Pond, Allerton Park, near Monticello, with 10 ppmw of liquid endothal. The results were satisfactory. Later work in May of 1960 indicated that curly-leaved pondweed could be removed by an application of 1 ppmw of granular endothal. When a large scale removal of *P. crispus* was undertaken, rates between 0.5 and 1.0 ppmw were found to be very effective. In contrast, 2,4-D and silvex were not effective on *P. crispus*. There is some indication that the time of application is important in the chemical control of this plant.

During the summer of 1960, other species of *Potamogeton* were treated. In Lillard Pond near Clinton, Illinois, liquid and granular endothal applied at the rate of 1 ppmw cleared the treated areas of an unidentified fine-leaf *Potamogeton*. Also, endothal was tried on *P. foliosus* and *P. confervoides;* however, results were inconclusive because of turbidity or other unknown factors.

Several areas of floating-leaf Potamogetons, presumably *P. natans* or *P. americanus*, were treated with a solution composed of 50 ml. of the liquid endothal diluted with water to make 0.5 gallon. This solution had the effect of completely defoliating the plants in a 10′ x 40′ area. Even 25 ml./0.5 gallon was an effective defoliant. However, additional work must be undertaken before the use of liquid endothal can be recommended for control of the floating-leaf Potamogetons.

Water milfoil, *Myriophyllum*, a very troublesome weed, was treated with various chemical preparations in 4 different bodies of water. In one pond, a natural die-off occurred during 1959 and 1960. However, during 1960, *Myriophyllum* was cleared from one of the treated areas by an application of 3 ppmw of liquid silvex and the weed population was greatly reduced in areas receiving 2.0 ppmw granular 2,4-D and 3.0 ppmw of granular endothal.

In September of 1960 another pond containing *Myriophyllum* was brought to our attention, and while I have not completed the identification of species we have under observation, two, and perhaps three different species of *Myriophyllum*. It remains to be seen whether the several species of *Myriophyllum* will respond differently to specific herbicides.

[1] Aquatic Biology Section, Natural History Survey, Urbana, Illinois.

RECENT OBSERVATIONS ON USE OF 2-4-D GRANULES FOR CONTROL OF AQUATIC VEGETATION IN MICHIGAN

J. W. Smith[1]

Timing is one of the important factors in getting adequate results in using 20% granular 2,4-D low volatile, long chain formulations. The matter of timing is especially important when making the first application on an area with a history of rank growth containing water milfoil, pondweed, coontail, and water weed.

It has been observed that if an evenly distributed application of granules can be laid out on a given water surface early in the spring on ice or on open water just after the ice has gone out, a considerable reduction of the above named weeds can be expected, within the area of treatment. It has also been found that if conditions delay treatment until plants are well established, results are slow in showing, but can be readily seen the following year if compared to an area left untreated.

To achieve results mentioned above, it is important to use granules at rates exceeding that which is recommended by most manufacturers of granular 2,4-D. Rates used by this writer in obtaining good results on the above weeds under a variety of conditions were not less than 50 or more than 60 lb/A (commercial product). Rates recently recommended by manufacturers of granular 2,4-D are 20 to 40 lb/A.

Considerable thought has been given to the matter of granule size and what constitutes a good mesh specification for both water and ice application. The majority of the work done or observed by this writer in Michigan this past year was done with granules having the mesh specification of 20/40.

Some experimental work was done with granules having the mesh size of 8/16. These granules are approximately three times the size of 20/40 and handled better under windy conditions. It was found, however, that the large granules were more apt to contain an excess of fines due to frequently handling of sacks or due to formulation processes.

This problem with large granules is being partially solved according to some manufacturers by a vacuum process at the formulation point. It could be further relieved by careful handling of sacks by manufacturers, distributors and operators.

In Michigan during the past year, granules have been applied on ice and on open water, depending on the conditions involved as it pertained to site of work and weather at the time of treatment.

Ice application has the advantages of ease of work layout and ease of application with tractor drawn equipment. It also has drawbacks, some of which are possibility of ice shift and breakup with material being distributed on the bottom unevenly, ice too thick to allow quick penetration and drop through, and slick ice surface. causing unsure footing and bad traction for equipment.

Much has been tried in the last year to make water application of granules more feasible and accurate. One and one half to three bushel electric rotary spreaders have been used, mounted on the front or back of shallow draft boats and fitted with movable transparent windshilds. Light bamboo poles and simple bouys and anchors worked out for layout purposes and to give control information. Enough material can be carried in a 14 foot boat to do as much as two acres without interruption. Larger boats or barges could work over large areas without interruption.

Labor is slightly more when applying on water due to the difficulty of laying out the work and keeping the application evenly distributed. It must be noted also, that labor is easier to obtain at the time of year that ice applications are usually made.

20% low volatile ester of 2,4-D on Attaclay granules of 20/40 mesh or 8/16 mesh size, if properly applied at rates of 50-60 lb/A of commercial product early in the growing season will give good control of many submerged rooted aquatic species. Generally, if the area to be treated is small and landlocked and is to be treated in its entirety, ice application is good. If area is part of large body of water with breakup or flow action possible, water application should be employed, using some method of establishing control of application, e.g., buoys or pole markers.

[1] Field Landscape Architect, Huron-Clinton Metropolitan Authority, Detroit, Michigan.

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HERBICIDE TOXICITY AND ECOLOGY IN MISSOURI FISH PONDS WITH REFERENCE TO AQUATIC WEED CONTROL[1]

Charles R. Walker[2]

There is urgent need for more effective ways to control undesirable aquatic plants in Missouri ponds where fish production and fishing are important considerations. The species of aquatic vegetation for which improved means of control are needed include duckweed, filametous algae, and most species of submersed plants.

Many new herbicides designed for industrial and agricultural weed control have been tested in the laboratory for toxicity to fish. Highly toxic herbicides were eliminated, and the others were tested in the field to determine their effectiveness in controlling aquatic plants. More than 2,500 field tests were made during the past three years with various application rates and numerous formulations of 50 herbicides on different stages of plant growth and density.

Observations were completed on 147 tests made in 1958 for actual weed control value and acute toxicity to fish food organisms. Ecological aspects of chemical weed control with reference to the potential effect on the fisheries were observed in over 1,600 tests on submersed aquatic plants. These considerations plus time, method and rate of application, formulation, mode of action, persistence and effectiveness of herbicidal activity, convenience, and economics influence the feasibility of the use of the chemical in fisheries management techniques.

[1] This investigation was supported by the Missouri Conservation Commission and in part with federal aid from the Bureau of Sport Fisheries under the Dingell-Johnson Project No. F-1-R-8.
[2] Biologist and Chemist, Missouri Conservation Commission, Fisheries Research, 903 Elm Street, Columbia, Missouri.

ALGAE CONTROL IN SWIMMING POOLS

Robert M. Stern[1]

The control of algae in swimming pools presents some interesting and unique problems which are not normally associated with algae control in lakes, ponds, and other waters.

The algae which are associated with swimming pool waters are usually classified from a practical viewpoint into two arbitrary groups—the free-floating types and the wall-clinging types. The free-floating types are mainly green algae. They grow rapidly and produce what is commonly termed "green water". The most common genera which make up this group are *Chlorella*, *Scenedesmus*, and *Kirchneriella*. The wall-clinging group are primarily members of the blue-green algae of which *Phormidium* and *Oscillatoria* are the principal genera. These latter are the most difficult to control in swimming pools.

It is necessary not only to kill and control the subsequent growth of all strains of algae in a swimming pool but also to be sure that no chemical added will cause any undersirable effect in the pool either from an esthetic or a public health point of view. An algicide must not react with other chemicals that have been added to the water or with naturally occurring minerals or organic matter normally present in the water. Such reactions which can and do take place may either partially or completely inactivate the algicide or cause cloudiness and precipitation in the water itself. A unique problem which has arisen in the control of algae in swimming pools, is the relationship of the filtering system to the effectiveness of an algicide. Most of the commonly employed algicides are readily adsorbed on sand or diatomaceous earth—the materials most commonly used as filter media. This adsorption phenomenon can be partial or complete after one or more passes through the filter.

The basic criteria essential for an ideal algicide are as follows: (1) Must be effective against all strains of algae, (2) Must be active for reasonable periods of time, (3) Must have no adverse effect on the pool water, (4) Must be of a low order of toxicity, (5) Must not adsorb on or be destroyed by the filtering media, (6) Must not precipitate out or react unfavorably when added to the pool, (7) Must be economical to use.

As in other fields of pest control resistant strains of algae have appeared, and so new chemicals and formulations are continually being sought to combat this problem. The most commonly used chemicals used for algae control in swimming pools are (1) quinones, (2) fatty amines, (3) quaternary ammonium compounds, (4) copper compounds, (5) miscellaneous metallic and organics too numerous to mention. None of these meet all of the criteria listed above, and few even the basic ones.

[1] Director of Research, Great Lakes Biochemical Co., Inc., Milwaukee, Wisconsin.

SOME LIMNOLOGICAL INVESTIGATIONS ON THE LONG-TERM USE OF SODIUM ARSENITE AS AN AQUATIC HERBICIDE

Kenneth M. Mackenthun[1]

During the past 10 years, Wisconsin alone has applied over one million pounds of arsenic trioxide to its lakes for the control of submerged aquatic vegetation. Some research has been done, but much, much more should be directed toward a determination of the impact of this operation upon our water resource. The work which has been done along this line with the aquatic herbicides is limited in scope and can only serve to introduce the subject.

Studies have been conducted on the arsenic accumulation on lake bottoms following the use of sodium arsenite for a period of years. Pewaukee Lake, near Milwaukee, has received more chemical treatment for weed control than any other lake in Wisconsin. It is a lake of 2,501 acres with a maximum depth of 44 feet and a total shoreline of 12.7 miles. During the past 10 years the shoreline area has received 218,000 pounds of As_2O_3 which, if retained and evenly distributed over the entire lake, would amount to 87 lb/A or 380μ g/g in the uppermost one inch of bottom. Fourteen bottom samples collected from three transects on September 1, 1959 (following the summer treatment program), indicate a range of 48 to 154μ g/g As_2O_3 with an average concentration of 83μ g/g. Thirty bottom samples collected from five transects on May 27, 1960, indicate a range of 10 to 82μ g/g As_2O_3 with an average of 49μ g/g. There is a definite tendency for the higher concentrations to appear in the deeper water in the spring samples. Pewaukee Lake has only a small stream serving as an inlet.

Fowler Lake near Oconomowoc, Wisconsin, is a lake of 82 acres, has a maximum depth of 50 feet, and is fed by the Oconomowoc River. Since 1950, this lake has received nearly 67,000 pounds of As_2O_3 which, if retained and evenly distributed over the entire lake, would amount to 816 lb/A or 3,500μg/g in the uppermost one inch of bottom. In February, 1957, bottom samples ranged from 8.8-27.5μg/g As_2O_3. On September 1, 1959, eleven bottom samples collected from locations throughout the lake ranged from 6.0-46.0μg/g As_2O_3 with an average of 24.0μg/g. It is believed that the flow of water through this lake has inhibited the deposition of arsenic.

Samples were collected from the outlets of several lakes and determinations of As_2O_3 content made. Pewaukee Lake had the highest concentration of As_2O_3 of those checked and thus received the most intensive sampling. Beginning on June 28, 1960, and continuing for 10 consecutive weeks, outlet samples contained concentrations of As_2O_3 ranging from 0.075 to 0.225 mg/L

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(mean of 0.170 mg/L). Sampling was instigated one week after the last weed treatment of the summer.

The As_2O_3 content of fish flesh was also investigated for five species of fish from Pewaukee Lake and an untreated control lake. Separate examinations were made of the fish flesh and the skin and scales. Fish examined were three or four years old. One largemouth bass was completely negative. One largemouth bass, one black crappie, and one bullhead showed $<0.05\mu g/g$ As_2O_3 in the flesh and $0.1\mu g/g$ in the skin and scales. One 7-inch bluegill had $0.064\mu g/g$ As_2O_3 in the flesh and $0.27\mu g/g$ in the skin and scales. Two yellow perch averaged $0.07\mu g/g$ in the flesh and $0.127\mu g/g$ in the skin and scales. All control fish were negative.

Recently it has been suggested that arsenic replaces phophorus in the bottom muds, thus making it available for plankton growth following a weed treatment. Pentavalent arsenic will appear as phosphorus in the standard phosphorus determinations. Aquaria tests indicate that a given concentration of trivalent arsenic will produce the same pseudo-phosphorus reading as pentavalent arsenic in 15 days in full sunlight at room temperature. This transition may take 40 days in the dark under cooler temperatures. In lake water alone, given concentrations of As_2O_3 remain fairly constant throughout the 40-day period. When lake water is superimposed upon three inches of bottom mud, arsenic (and pseudo-phosphorus) concentrations diminish rapidly—especially after 10 days. A small amount of arsenic is still present in solution in the aquaria at the end of 40 days but much has been absorbed by the layer of mud.

[1] Chief, Aquatic Nuisance Control Committee on Water Pollution, Madison, Wisconsin

NITRATES IN WEEDS CAUSE ABORTION IN CATTLE

J. M. Sund, M. J. Wright, and J. Simon [1]

Serious economic losses from unexplained abortions in cattle grazing weedy lowlands have occurred with regularity during the past 50 years. Losses were often staggering. Four hundred non-infectious abortions were reported during 1954 in brucellosis-free herds grazing on a 70,000-acre marsh in central Wisconsin. No evidences of reproductive diseases were found. No explainable symptoms existed which ruled out a possible cause from alkaloid or glucocide properties of plants. Prior to, and after, aborting the cows appeared normal and "bred back" within two weeks.

A 40-acre weedy pasture where abortions had occurred for a number of years was selected for study. Grazing experiments conducted during 1956 and 1957 proved that several weeds were responsible when 27 of 29 pregnant heifers aborted on weedy areas and only one of 18 aborted on the areas made weed-free when sprayed with herbicides.

Tests for nitrate showed high, medium and low accummulations of nitrate among 90 species present. Thus nitrate-containing weeds were responsible.

A simultaneous feeding trial with KNO_3 placed in the rumens of 9 heifers proved nitrate will produce the same tissue changes on fetal organs and on the placentas as were found in the pastures. Thus, we can say nitrate in weeds cause abortion in cattle when grazing lowland areas with numerous kinds of weeds present.

An abortion can occur at any stage of gestation. Fetal organs showing marked degrees of degeneration were, in order of severity: Kidneys, spleen, liver, inflamed intestines and abomasum, thickened lung arteries and degeneration of posterior lobes of the lungs. The placenta showed grayish rotten cotyledons, edema (water pockets) in the tissue, was thick and heavier than normal and small-pox spots which contain calcium and perhaps other minerals.

For whatever reason, cattle would eat weeds, brush or brambles, and on occasion they seemed to prefer nettle and other weeds to sweetclover and good grass. Good forage was available on one pasture but the cattle had topped-off large patches of nettle and 84 of 140 had aborted by mid-June.

Abortions were most prevalent during May and June and again in September. These are the periods when weeds are most succulent and contain the most nitrate. Abortions usually followed rainy periods and weeds contained the most nitrate following rains. Stage of maturity had little effect on nitrate content and acceptability of elderberry.

A complete eradication of weeds is necessary to prevent all abortions. This cannot be accomplished in one year if the area is very weedy. Weeds reappear until a good, solid, vigorous turf is developed. On areas sprayed for the first time: 1 of 8 aborted in 1956; all 6 aborted in 1957. Weeds were not well controlled in 1957 on the area sprayed for the first time because the first spraying was delayed until the weeds were a foot tall and frequent rains occurred throughout June and early July. On the weed-free areas in 1957 all 10 heifers had live calves by fall.

The addition of P, K and minor elements delayed the time of abortions by one month but did not prevent them entirely on area fertilized but not sprayed. Nitrate contents of weeds were lower during the spring period on the fertilized area than on the unfertilized area; by fall these differences were not apparent.

Summary: Complete weed eradication will (1) prevent abortion and (2) increase production of Kentucky bluegrass. Fertilization will further increase production and "hold down" weed growth.

[1] Agronomy and Veterinary Science Departments, University of Wisconsin. Supported in part by Hatch funds.

APPLYING WEED RESEARCH FINDINGS BY REGULATORY AND EXTENSION PERSONNEL

William Lobay[1]

Reasearch into the various aspects of weed control is quite extensive. Every agricultural institution throughout this country is carrying out some form of research as well as a tremendous amount of excellent work done along this line by private concerns. Much of this work is pure research and may be only indirectly related to the practical weed problem. However, a large amount of work might be termed applied research, that is, testing certain materials or methods which can be immediately and directly applied by the farmer. It is for this applied research that extension personnel, and regulatory officers to some degree, are continuously looking in order that they may carry this information to their client, the farmer.

Being in contact with the Agricultural research institutions and attending weed conferences such as this, it is not difficult to obtain various applied research information on weeds. The extension man, however, must be able to sort out these findings and determine which are going to be applicable to his area.

One of the main functions of an extension officer is to interpret research findings, bring them to the farmer, and show him what it can do for him. This can be done through meetings, press, radio, and television. However, one of the quickest and most effective means of bringing the story to the farmer is through demonstrations. It is this method or means which I wish to stress and on which I wish to elaborate.

Demonstrations can be set out by the extension officer or the weed inspector. We find however, that such a demonstration is not as effective as if one were set out by the farmer himself, perhaps under the guidance of the local agricultural official. If a herbicide showed excellent promise to effect good weed control on a practical basis, there should be no hesitation in demonstrating it on as an extensive a scale as possible. Weed

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inspectors should be drawn into this program and together, these men should endeavour to obtain farmer co-operators. Weed inspectors are mentioned because through such work they can gain the confidence of the farmer.

Usually it is not difficult to get a farmer co-operator. There can be no better and effective demonstration which will obtain farmers interest and acceptance than that done by the farmer on his own problem field, with his own equipment, in his own way. Although it should be guided by the agricultural representative and/or weed inspector, the farmer should feel he is doing it himself. He should be given instructions so he fully understands what he is doing. During the summer through field days and tours the trial or demonstration in each area is shown and explained to the farmers. The farmer who puts the trial out is usually happy to tell the visitors what had been done and point out the results; the co-operators are often quite convincing and, indeed, very helpful to the extension officer.

To set out effective weed control demonstrations requires planning and some help. Assistance may be obtained from the technical personnel of commercial organizations. Such men usually have a professional background and are well qualified to do this work. They not only will set out demonstrations involving their own products but often will assist with other work. Let us not overlook this force.

I would like very briefly to outline one extensive demonstration program carried out in Alberta last year. In this province the Number 1 annual weed is wild oats. Last year research findings indicated that two herbicides, 2,3-dichloroallyl diisopropylthiolcarbamate (Avadex), a pre-emergence spray, and barban (Carbyne), a post-emergence spray, showed much promise as selective weed killers in certain crops. The National Weed Committee recommended their use. The Weed Division of the Dept. of Agriculture immediately relayed this information to all extension and regulatory personnel pointing out its possibilities and suggesting that demonstrations be set out in as many areas as possible as one method of acquainting the farmers with this herbicide There was a very enthusiastic response to this proposition. Hence, arrangements were made to undertake a demonstration project on a provincially organized basis.

The agricultural area of the province is divided into some 50 municipalities, or counties. In each county there is an Agricultural Service Board, each with a full time Field Supervisor (weed inspector) and an extension officer serving each area. In 36 of these areas the extension machinery and Service Boards went into high gear and soon a force of over 350 farmers were putting out Avadex and Carbyne demonstration plots—all work assisted by Agricultural representatives, weed inspectors, and in some cases technical men employed by private concerns. All work was co-ordinated by the Dept. of Agriculture; the herbicides in all cases were purchased out of the grant funds available to each county where Service Boards are organized. I wish to stress again that these demonstrations were not research trials; we were demonstrating a proven fact—Carbyne and Avadex at recommended rates on recommended crops will control wild oats effectively. Locally organized field days brought many farmers to see these trials. Due to drought, hail, and other factors some of these were abandoned, but a large portion were harvested, threshed, and yield summaries obtained for use locally. The farmer on whose place farm demonstrations were conducted promised to attend winter meetings together with the extension man and the weed inspector. An aggressive co-operator can be very influential in his community.

Agriculture has grown up and tomorrow's farmer must be ready to treat it as the big business it is. The farmer must become increasingly more efficient in production and in his operation of the farm as a business. His efficiency will determine whether he will increase his net income or just barely maintain it at the present level or perhaps even go down below the line. The farmer can achieve increased efficiency by two methods —improved technology and improved management. This is where applied research comes in, this is where we as extension and regulatory workers come in. Upon one shoulder lies the responsibility and obligation to show the farmer how to adopt biological and mechanical inovations, sprays and machinery, not because they are available but because their use is necessary to keep the farmer competitive.

Contemporary weed research has provided us with a tremendous amount of good practical information. Every means should be employed to put over such practical research findings to the farmer. We consider that through good demonstrations approved weed desearch findings can be very quickly and effectively introduced, "sold", and accepted by the farmer. Extension and regulatory men can play a very important role here and have the satisfaction that their efforts were not in vain.

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PROCEDURES FOR APPROVAL OF PESTICIDES IN CANADA

J. O. Forbes [1]

Approval of Pesticides in Canada is regulated by the "Pest Control Products Act." The 1939 Act is a consolidation and amendment of the original "Agricultural Pest Control Act" which was established in 1927. Specifically, it is "an Act to regulate the Sale of Products used in controlling Agricultural Pests." By definition a Pest Control Product means "a product used, or represented as a means for preventing, destroying, repelling, mitigating, or controlling directly or indirectly an insect, fungus, bacterial organism, virus, weed, rodent, or other plant or animal pest."

The Act is administered under the authority of the Minister of Agriculture for Canada by the Pesticide Unit of the Plant Products Division, Production Service with headquarters at Ottawa, Ontario. Close co-ordination is maintained with the Food and Drug Directorate of the Department of Health who are interested mainly in the tolerence factor of pesticide materials. At present, there is no legal requirement for tolerance information on application for registration but authorities assure me that consideration is always given to this factor before registration is granted. This is particularly true with any pesticide that might cause food contamination.

The Pest Control Products regulations apply to all pesticides including the spreader, sticker, emulsifier, or activator that is intended for mixing with a pesticide. Application for a registration number is made in duplicate on a prescribed form and calls for the following information in detail.

The brand name—this should, whenever practicable outline the active substances, the physical form and the purpose of the product being presented. It may also include a distinctive trade mark. An example would be,

"Blank's Liquid Herbicide (containing Butyl Ester of 2,4-D)".

The physical form—this refers to whether it is liquid, paste, powder, etc . . .

The chemical form—this requires the name and percentage of each ingredient and active substance according to their appropiate common name and chemical formula. The total percentage must equal 100; in other words, leave nothing out. This technical information is treated with strict confidence by the government authorities but must be obtained if full analyses are to be compiled.

Three copies of all claims as to the purpose of the pest control product must be included. Here is where the name of the pests that are controlled or exterminated effectively should be included. This must also contain such information as to the time and rate of application, frequency of application, appropriate precautions in the use of the material and if there is a

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toxicity hazard to human or animal life the toxicity factor should be included.

While on the subject, I should outline the attitude of the Food and Drug authorities on toxicity and carcinogenicity in particular. To quote from a speech given by Dr. R. A. Chapman, Assistant Director, Scientific Services, Food and Drug Directorate, Ottawa, to the C.I.F.T. in Winnipeg in June, 1960:

"—we do not consider it necessary to adopt any so-called cancer clause. Any carcinogenic properties of a compound are simply another manifestation of toxicity and we believe should be judged as such. On this premise and with the active cooperation which has been promised us by informed individuals and groups, knowledgeable in this field, I believe that it should be possible to develop regulations and a list of acceptable food additives which will not be too restrictive but will provide the necessary authority to prevent any hazard to health."

The next requirement is three typed or printed copies of the label that will be used on the container. Section 9 of the Act requires that the printing be conspicuous, legible, indelible, and in logical sequence on the container, tag, or label. The label must carry the name and address of the manufacturer or vendor, the brand name, registration number, and guarantee. If poisonous substances are contained this must be clearly stated with the antidote required.

Two "don'ts"—No information that is inconsistent with or qualifies a guarantee may be shown on the label. Nor may any implication of approval or recommendation by the Government of Canada or by any government department be used. This also applies to any advertisement for a product.

I mentioned the guarantee. This simply requires a mention of the common name, if one has been approved, the active ingredients, indicating the amount of each, and words "Effective for the purpose claimed." Where no common name has been approved the chemical name shall be given.

Finally the application requires the name and address of the manufacturer and whether the product already has a registration number. If the product is imported for sale in Canada the application must carry the signature of the organization's representative under the product will be labelled for sale as well as the Canadian agent's signature who accepts responsibility for the product.

These are the steps to follow in seeking approval of pesticides in Canada. Once a product is registered, it may be offered for sale during the currency of the registration which is from January 1 to December 31 of each year. The registration must be renewed from year to year and will receive the same number as long as no change occurs in the brand or guarantee. Cost is $20.00 for the original application and $5.00 for each renewal.

Two factors remain. These are of concern where an application is made to register a pesticide for the first time. Evidence must be given as to the practical effectiveness and safety of the product. Also the protocols of the experiments establishing the comparative mammalian toxicity are required of any new material contained in the product. This evidence must be supported by reports of scientific experiments and should indicate whether they are laboratory or field testing plus the number of replicates of the tests. Results should be given on a comparative basis between treated and untreated checks as well as comparisons with a recognized control.

An essential point here is that while scientific evidence from company employees is given full consideration, the department reserves the privilege of seeking impartial results from government research stations and university departments. These reports are more acceptable as evidence in support of an application for registration. This is where the National Weed Committee plays an important role in Canada. Annual meetings are held of the Eastern and Western sections at which the Provincial and Federal research personnel assess all research data and either approve, reject, or assign for further testing those herbicides being presented for use in Canada. The National Executive at Ottawa maintains close liaison with the Pesticide Unit and provides technical information when requested for consideration by the authorities on an application for registration.

Other regulations exist governing such things as packaging, statement of net content of containers and the method of taking official samples. Packaging regulations are designed to protect against deterioration, fire hazard, and volatility. This is purely a safeguard but necessary for public protection.

Right of entry by authorized inspectors is permitted upon any premises to make an examination of any pest control product in containers or in bulk. Canadian authorities inform me that they appreciate the excellent co-operation of the commercial concerns in respecting all of these regulations and hope for continued co-operation in the ever-increasing requests for approval of pesticides.

[1] Chief of Weed Control Section, Manitoba Department of Agriculture and Conservation.

OBLIGATION OF SELLERS AND USES OF PESTICIDES

J. D. Furrer[1]

The obligations of sellers and users of pesticides overlap. There is no definite point where one starts or stops. Each has responsibilities to the other.

The seller's principal obligations. Since the seller comes first, let's discuss his responsibilities as we see them.

1. He owes it to himself and his customer to know the product.
   (a) Read and re-read the label and accompanying literature.
   (b) Get acquainted with the research work of local and other experiment stations.
   (c) Find out about demonstration and plot work.
2. When giving recommendations, follow those printed on the label and supplemented by research and extension circulars. Recommendations should be easily understood and to the point. Often times it is necessary to print labels which gave ranges in the amount of product to use. These ranges in dosage can be more closely pin-pointed by consulting college publications or by contacting specialists.
3. Don't make experimenters of the users. If you are unable to locate information on certain use, don't be afraid to tell the customer that the product hasn't been approved for that use or that you don't know.
4. Don't sell an item just to move it. You're hurting your reputation as a dealer, as well as doing the customer a disservice.
5. Some sellers or manufacturers have an obligation to "weed out" some of their products of marginal value. Salesmen have an obligation to the dealer, as well as to the manfacturer. Don't load your dealer with items he has little chance of moving.
6. Follow up—see if the user properly applied the material and obtained the expected results. If he didn't, find out why. The results, good or bad, will increase your product knowledge.
7. As manufacturers and dealers you are entitled to, or should we say obligated to a fair margin of profit. Most consumers will gladly pay it if they receive a quality product, reliable information and service.

Obligations of the users. In many instances the obligations of users are the same as the sellers:

1. He too should acquaint himself with the product, the label, and his county agent's recommendations.

2. Follow the recommendations provided. There is always a tendency to skimp on costly materials and add a little extra of the inexpensive items.
3. Know your equipment—how much water it applies, what rate to travel, etc. Have your equipment in first-class working condition.
4. Take all precautions set forth with respect to the saftey of the operator, your neighbor, livestock, and crops.
5. Clearly label all unused material and store it in a safe place out of the reach of children.
6. Beware of bargain materials. Buy from a reputable dealer.
7. Report your results to your dealer. He's interested in successes as well as failures.

Obligations of all of us: First, we all have obligations to get the job done the way it should be done. Manufacturers and those employed in the educational field have an obligation to make available to the users and sellers of pesticides the very best information. We particularly need to put forth more effort in the area of dealer education. After all, who is in a better position to give out information on a product that the dealer at the time he is selling the material? We have put forth some effort on dealer education in Nebraska but we have a long way to go.

A second area that needs special attention is the establishment of tolerances for 2,4-D, 2,4,5-T, and other widely used chemicals on some of our commonly grown crops. For instance, tolerances of 5 ppm of 2,4-D have been established in citrus fruits, apples, pears and quinces, and asparagus. But no tolerances have been established for crops in which most 2,4-D is used, namely corn, sorghum and small grain.

This summer we had a situation develop in Kansas and Nebraska which almost made the cranberry fiasco look like peanuts. Much of our wheat was weedy and in need of 2,4-D spraying for weed control. The word was out—there were no residue tolerances for 2,4-D on wheat. The recommendations were that if wheat were sprayed 50 days before harvest there should be no residue. This was well and good, but most weed problems didn't develop until late in the season. What were farmers to do? They had used 2,4-D in previous years without complaint. Good wheat developed but unless it were sprayed it would be impossible to harvest it. Some took a chance and had their wheat sprayed. Word got around and eventually FDA in Kansas City stepped in.

FDA had a job to do. No tolerances had been established on wheat so accordingly, any wheat found with even traces of 2,4-D was subject to seizure regardless of when it was sprayed. The scare began to snowball. Elevators posted signs stating they would refuse to take wheat sprayed with 2,4-D. Stories circulated about additional FDA inspectors employed to check for 2,4-D residues. The situation was almost out of hand.

Our leading farm organizations, wheat marketing interests, aerial operators, prominent farmers, and others wrote and wired congressmen asking for help. In turn, our congressmen asked us for help. The facts were supplied. Our senators met with the Secretary of Health, Education and Welfare. Word came out of Washington that 2,4-D had not created any problems in previous years, that it was a safe chemical, and spraying late in the season should not leave any undesirable residue on the grain. Panic subsided, spray operators again set their equipment in motion, farmers harvested a bumper crop of clean wheat, and elevator operators breathed a sigh of relief.

The above case is a thing of the past and incidentally is documented in the Congressional Record. However, we are still without residue tolerances for herbicides most widely used on some of our most important crops. Whose responsibility is it to establish those residue tolerances?

A third obligation of all of us is to eliminate inconsistencies in usages and approved tolerances. It's hard to explain to farmers why 2,4-D tolerances are allowed in fruits and vegetables but none in grain crops; why tolerances up to 30 ppm on dalapon are allowed in asparagus and 75 ppm on flax, but traces in alfalfa are likely to get the grower in trouble.

One last example—this one on inconsistency. Recently I received the approved uses of amitrole. On every page there appeared the statement, "No crop should be grown for 8 months following treatment. Land to be cropped should not be treated after October 1." However, when I turned to the special uses section on Canada thistle and quackgrass control in corn, here's what it said, "Spray thistles and quackgrass in spring when 6-8 inches high and growing vigorously. Wait 10-14 days. Plow, prepare seedbed and plant corn immediately. Keep livestock off treated areas."

These examples of inconsistencies in chemical usage and tolerance variations are but a few of the many which could be cited. A point I want to make—such inconsistencies and variations in approved uses bring about a certain disregard for all instructions, recommendations and regulations.

We need to work toward the elimination of inconsistencies in patterns of chemical usage and parts per million tolerances. The establishment of tolerances for chemicals proven to be safe to warm blooded animals should be simplified.

[1] Extension Agronomist, University of Nebraska, College of Agriculture.

OBLIGATIONS OF INDUSTRY

Clinton C. Zinter,[1],

It would seem that the manufacturer, seller and user of pesticides must share the responsibility in the proper use of pesticides to conform with the U. S. Food & Drug Act and any amendments thereto. The manufacturer, of course, has a legal responsibility which is basically completed when the label is approved on the pesticide. The user also has a legal and very basic obligation in that he is the one that makes the final step in determining whether the product is used correctly.

The distributor, or dealer, should share with the manufacturer the responsibility of education in the correct use of a pesticide, but since those involved in distribution do not have direct control of manufacturing, labeling, or application, it is our belief that they have no legal responsibility, unless they were to recommend the use of a pesticide in a manner other than is suggested on the label.

Those businesses involved in the distribution of chemicals are sometimes criticized for not providing enough information to the actual users. A legitimate dealer, or distributor, is faced with two problems. One, normally the margins on chemicals are not large enough to justify an extensive educational program and secondly, competing dealers are sometimes permitted to sell chemicals without having adequate knowledge of the product they are selling, or interest in providing such service. The odds are that agricultural chemicals are not the basic source of income for many dealers and consequently each is going to be spending the great bulk of his time and interest on the items that make up the bulk of his livelihood. This attitude would quickly change with greater incentives.

In defense of the manufacturer, I think it must be said that the information put on the label of the product, plus other educational material that usually is included, is sufficient and if properly followed would insure that chemicals will be used correctly. In defense of the dealer it must be said he has a very difficult problem in trying to keep up to date with all the new chemicals and the specific uses for these chemicals. Even those of us who spend a good part of our time in education, research or promotion have a tough job keeping up with names of new agricultural chemicals that are very similar in name and use, plus the fact that the proper use of these products is often changing.

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The Agricultural Extension Service and the Regulatory people are certainly doing all they can to help educate pesticide dealers and users and have made considerable progress. It should be pointed out that the use of chemicals in agriculture is relatively new. The cranberry fiasco was probably unnecessary, yet there is some good that could come of it in that all of us from manufacturer through user are now more alert to the possible misuse of herbicides and that an educational program must be a continuing one. Even with all the precautions taken in the production, distribution and use of medicines and drugs, we still have some instances where they are misused and for the most part the responsibility has to lie with the user.

In conclusion, I might suggest that the only justification for making a profit in any business, including agricultural chemicals, is by providing goods or services, which, of course, includes instructing the user on the safe use of pesticides. This involves a never ending job of education.

[1] F. H. Peavey & Company, Minneapolis, Minn.

RESPONSIBILITY OF MANUFACTURER

Robert Hamman [1]

Perhaps the best way to outline the responsibility of the manufacturer of pesticides is to trace the steps necessary to develop a new compound from its inception up to the time it is brought on to the market for sale and use. By this method, the responsibility of the manufacturer should become self-evident.

In early days, pesticides were developed largely through individual efforts and use in the field involved a minimum of regulations and recommendations. Now the development of a new pesticide takes a minimum of four to five years from test tube up to the point it can be locally used in the field and may involve organic, physical and analytical chemists, plant pathologists, plant physiologists, entomologists, agronomists, horticulturists, toxicologists, extension personnel, patent attorneys, market survey specialists and others too numerous to mention.

Those of us present here today are well aware of the requirements, the time and the expense necessary to place a new chemical on the market. However, one has only to read our daily papers and certain of our national magazines to realize that the general public is not well informed.

Of the thousands of new chemicals synthesized every year, an average of one out of every 2,000 may eventually find its way to a use on the farm. By the time one successful compound is conceived by the mind of a chemist, screened by the biologist, evaluated for field performance by industry and various public agencies involved, shown to be safe, certified for use by government, and produced commercially by chemical engineers, an expense bill of one to two million dollars may be incurred. This expense includes not only the cost of the one successful compound, but also the costs by reason of all failures encountered along the way. Not enough people realize that a label attached to a pesticide container represents one of the most expensive pieces of paper being printed today. This label represents the efforts of the most advanced scientific procedures and minds in the fields of chemistry, toxicology, biology and engineering. Each of you can claim a part in the preparation of practically every pesticide label on the market.

Let us look at what steps are required before the sale or use of a pesticide can result even after the primary and secondary screening can determine biological activity. First, arrangements are made with state and federal experiment stations for large scale field testing. The wealth of agricultural stations in the United States places us in a unique position. Facilities for testing compounds in many other countries are quite limited, but in the United States a chemical may be tested under a wide variety of soil types and different weather conditions, as pesticides may perform differently in one section of the country as compared to another. The experiment station program provides for the farmer within his own state the best information on the activity of each chemical under local conditions. Second, toxicological studies are begun, usually with a recognized outside independent laboratory. A two year chronic study on rats and at least a one year chronic study on dogs is undertaken. By the time these steps are finished more is known on the toxicology of the pesticide than is known about many of the ingredients usually present in the foods that we eat. Third, since many pesticides will leave a residue, at least under certain conditions of use, the analytical portion of the research program takes on greater importance. Most research programs involving performance data must take into consideration the procurement of samples of the crop for residue analysis. Non-specific methods may be used as long as the pesticide history of the crop is known, but analytical chemists must also prepare specific methods of analysis to be presented with a petition for regulatory purposes where the history of application of insecticides to the plant is not known. Due to the stringency of the tolerance requirements of the Miller Bill, industry is expanding analytical laboratory facilities and closer cooperation is being established between industry and state analytical chemists.

The synthesis of radioactive pesticides is rapidly advancing our knowledge concerning mode of action, fate of residues and other biological and chemical unknowns, which will some day be a boon to the synthesizing of new pesticides. The final phase of a development program is the registration of the pesticide as well as the establishment of tolerances if a residue does exist. If analytical data indicate that a residue problem does not exist, the pesticide may simply be registered with the United States Department of Agriculture and the tolerance need not be established. However, if a residue problem does exist, a petition for the establishment of the tolerances in accordance with the regulations of the Miller Bill is undertaken. Upon submission of a petition to the Food and Drug Administration, a 15-day period is set aside during which the petition is checked for completeness as regards the requirements of law. If found to be complete, the petition is given a number and officially filed. The Department of Agriculture now has thirty days in which to certify that the pesticide chemical is useful for the purpose for which a tolerance is being sought and that the proposed tolerance reflects the amount of residue likely to result when used in the manner indicated. Agriculture may take an additional thirty days if it deems necessary before certification. Following this, Food and Drug has ninety days in which to act upon the petition, at the end of which an order regarding the petition is published. If the petition is amended during this period, additional time may be taken by Food and Drug to examine the data. Thus, it is evident that a petition man be under advisement for 165 days or more before it is handed down. Add to this, the time required to gather the data, prepare the petition and the time necessary to place the chemical on the market after the tolerance has been established and it becomes evident that a year can easily pass by after all the facts on the pesticide are known before is can be recommended and sold.

This period of deliberation alone by the two government agencies involved should provide some degree of comfort to a pesticide-shy public.

Now it is quite evident that a manufacturer has many obligations all during this development period. However, these obligations do not end here. He must produce the material in advance of its need in the field, train personnel in its proper use and begin a broad educational program to insure safe and proper use when the material is put into the hands of the user. In this stage, a manufacturer must conform to state and federal pesti-

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cide regulations as well as the many other regulations covering general business operations of today.

While it is true that a manufacturer is also motivated by the desire for profit, I think that all of us, state, federal and commercial people can take some pride in our contribution to a better agriculture. We are all paving the way toward assurance of an ample food and fiber supply for the years to come.

[1] Geigy Chemical Co., Yonkers, N. Y.

OBLIGATIONS OF REGULATORY PEOPLE AS TO THE USE OF PESTICIDES

Sig. Bjerken [1]

In the field of weed and insect control many complications develop due to sellers and users of pesticides not being fully aware of the fact that there are specific weeds and insects, and also that it they are not applied at the proper time, using the correct dosage, they become damaging rather than beneficial.

Research people provide us with their findings in applying proven practices and techniques in dealing with the control of grass and broadleaf weeds.

Industry, through their efforts, provides us with equipment and herbicides at a nominal cost for the eradication of weeds and insects.

Extension people demonstrate and sell the desirability of the use of these pesticides to the people.

Regulatory people stand as the first line of defense against the introduction of new weeds and provide the necessary supervision in the eradication of the weeds we now have established.

We, as regulatory people, when we return to our respective states and provinces should do so with the one thought in mind—that in order to safeguard our program we have certain obligations to carry out. It is not enough to merely tell a farmer to use 2,4-D for the control of broadleaf weeds. Rather, we must acquaint him with the other factors such as whether it should be an ester or an amine, the right stage at which to spray, how to calibrate his sprayer, explain the meaning of the label, etc. Likewise, we must not merely tell a farmer to use a grass killer for grass weeds. There is much more to it than that.

We must acquaint the dealer with his responsibilities in the selling of pesticides. For example, before he sells a pesticide to a farmer he should first inquire as to what weeds he wants to control, the stage of the crop, adjacent crops, the type of sprayer to be used, the amount the sprayer puts on per acre, and be sure the purchaser understands the information on the label. We need to work much closer with the dealers. We should also see that custom plane operators, ground sprayer operators and individual operators are aware of their responsibility in safeguarding our program as well. An occasional check should also be made of the spraying performance and the results obtained.

Full time employment of county weed supervisors is desirable so that most farmers can be contacted before spraying gets under way to acquaint them with the solution to their weed or insect problem, discussing what product he should apply etc. In other words, with the selective chemicals we have today every acre of infested crop lands can be cropped and weeds controlled at the same time.

We have reached the crossroads as to the future use of pesticides. Carelessness in their use will add to legislation which will curb the use of these products and if this occurs it will be because we have failed to a large degree in our supervision of the program.

It is not sufficient that we have a state weed supervisor or a district supervisor. The time has come when we should have a full time county inspector or supervisor in every county in cooperation with the county extension agent to guide people as to the proper use and application of pesticides. The use of these products is essential in the field of agriculture and as regulatory people let's do everything within our power to safeguard the use of these products so that continued progress will be made in weed and insect control.

[1] Minnesota Department of Agriculture, Dairy & Food, St. Paul, Minnesota.

SOME CAUSATIVE AGENTS RELATED TO THE DORMANCY OF THE HARD-SHELL BULB OF WILD GARLIC

Frank S. Davis, Elroy J. Peters, and O. Hale Fletchall [1]

Field studies to date, in Missouri and elsewhere, have demonstrated that failure to eradicate wild garlic is due to dormancy of its hard-shell bulbs. Thus, dormancy is of considerable importance in any wild garlic control or eradication program. This paper reports studies dealing with the nature and some causes of this dormancy. Among the causative agents, moisture, light, temperature, passage of time, bulb size parent plant and outer protective leaf were studied.

In all the studies essentially the same technique was employed. Six replications of 25-bulb cultures were planted in sand at a 1-inch depth in 24-ounce wax-coated cups. Moisture level in the sand was held constant by weighing and adding water whenever necessary. Constant temperatures were maintained by placing the cups in modified refrigerators having sufficiently sensitive controls to maintain temperature at 2°C. Alternating temperatures were applied by transferring the cups between chambers set at different temperatures. The criterion used for determining the end of dormancy was the emergence of a shoot from the sand. There was only a very short lapse of time (1-2 days) between sprouting of the bulb and emergence of the shoot.

Moisture—"Dry," "moist," and "wet" conditions (25, 50, and 75% of field capacity) in the sand medium were compared. Sprouting was essentially the same at the "moist" and "wet" moisture levels after 60 days, but almost negligible at the "dry" level.

Light—A trend was noted for enhanced sprouting of bulbs given a 3-minute exposure to full sunlight over that of those given no light. However, the difference between the two means was not statistically significant.

Temperature—Temperature of the germination medium had a definite effect (Table 1). Little sprouting occurred at low (3°, 10°C) or at high (30°C) temperatures. Slightly better sprouting occurred at a moderate temperature (20°C). The best sprouting resulted from alternating cool (15 hours) and warm (9 hours) temperatures. The best combination of alternating temperatures was 10° and 30°C, which resulted in over 36 percent germination.

Table 1. Effect of temperature on the dormancy of the hard-shell bulb.

Temperature condition	Percent sprouting (105 days)
3°C	1
10°C	3
20°C	9
30°C	5
3°C (5 days)-20°C	8
3°C (25 days)-20°C	9
10°C - 20°C	10
20°C - 30°C	17
10°C - 30°C	36

Time—Passage of time alone was insufficient to break dormancy in this study. A combination of time and other factors was very effective, as shown under other headings.

Outer protective leaf—Removal of the outer protective leaf resulted eventually in higher germination.

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However, the bulbs remained essentialy quiescent for 60 days after removal of the leaf before beginning to sprout.

Table 2. Effect of removal of various portions of the outer protective leaf on the dormancy of the hard-shell bulb.

Portion of leaf removed	Percent sprouting (105 days)
Entire leaf	46
Terminal half	41
Basal half	44
Abaxial half	49
Adaxial half	19
Small circle at base	13
Leaf intact	11
Leaf intact-cracked	10

Bulbs having the hard outer leaf cracked, but not removed, did not sprout nearly so well as those having the outer leaf removed. Three modifications of the outer leaf gave essentially the same amount of sprouting as complete removal. These were (a) removal of the convex abaxial surface of the leaf, (b) removal of the terminal ½ of the leaf, and (c) removal of the basal ½ of the leaf. Removal of the flat adaxial surface of the leaf or of a small circle of tissue directly above the meristematic region resulted in substantially less sprouting than did complete removal.

Bulb size and plant type—Small bulbs produced by both scapigerous and terminal plants sprouted more rapidly than intermediate- to large-sized bulbs. No differences in the degree of dormancy were observed in bulbs produced by scapigerous and terminal plants.

Changes in the state of dormancy under field conditions—The rate of sprouting from random samples taken periodically from the field and placed under controlled conditions remained approximately the same from August 1 through October 1. After this date it increased sharply, remained at a high level for a short time, and then declined. This observed increase in the rate of sprouting after alternating daily warm and cool fall temperatures is in agreement with the observed effect of similar conditions produced in the laboratory.

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Cooperative investigations of the Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, and the Missouri Agriculture Experiment Station.

SOME FACTORS AFFECTING THE ACTIVITY AND GROWTH OF BUDS ON QUACKGRASS RHIZOMES

R. E. Meyer and K. P. Buchholtz [1]

The aggressive rhizomes of quackgrass grow to a length of several feet, penetrating hard soil, potato tubers, and even other quackgrass rhizomes. In May and June new rhizomes are produced. From the middle of June to mid-July the buds on the rhizomes remain dormant. In the fall the rhizome tips turn up producing a shoot. At any given time of the year, however, most buds remain in a dormant condition. Some factors affecting the activity of these buds were considered.

The effect of repeated nitrogen applications on summer dormancy was studied. Two areas received initial 100 lb/A broadcast applications of nitrogen as NH_4NO_3. One of the areas received four additional 50 lb/A monthly applications of N. A third area was not treated. At two-week intervals rhizomes were dug, washed and cut into 20 mm single-node sections. For each of the three treatments, five rhizome sections were planted in each of ten 125 ml Erlenmeyer flasks containing 50 ml of 0.8% agar. After incubating the rhizomes for 15 days at 30°C, the bud activity was recorded. Rhizomes from areas receiving no N demonstrated typical summer dormancy in June and July. The initial N application reduced the summer dormancy. Repeated N applications further hastened recovery from the dormant period.

The effect of temperature on bud dormancy was studied. The bud activity of single-node sections grown in the agar containing flasks was appreciably reduced at temperatures above 30°C. At temperatures between 0° and 10°C the growth rate was reduced but the buds did not remain dormant. Maximum shoot growth occurred at about 25° to 27°C.

Single-node sections were grown in atmospheres of CO_2 and O_2 ranging from 0.03% to 80% and 0% to 21%, respectively. The concentration of CO_2 was increased by using mixtures of CO_2 and air while the O_2 concentration was decreased by combinations of air and N_2. Bud activity was little affected by CO_2 concentrations less than 10% while all O_2 concentrations less than 15% reduced bud activity.

Both greenhouse and field experiments indicated that apical dominance influenced bud activity. In the greenhouse the activity of the various bud positions on eight-node rhizome sections was studied. The four treatments included: 1) eight-node sections with an original terminal shoot, 2) eight-node sections with no original terminal shoot, 3) two four-node sections and 4) eight single-node sections. The rhizomes were planted in a rich greenhouse soil with the sectioned pieces placed in sequence according to bud position. After 22 days bud activity was recorded. The original shoot on the rhizome suppressed bud activity at all positions. Buds at the youngest ends of the rhizome sections with no original tops had the highest bud activity. Single-node sections had about the same activity at all bud posiions.

In a field quackgrass sod twelve 3 x 3 ft plots were stripped of shoot growth. The surface five inches of half the plots was cut at 2-inch intervals in two directions. Shoot counts after 1 week indicated the food materials in the uncut rhizomes was probably more readily mobilized for the new shoot growth in the old crowns. After 2½ weeks, however, the number of new shoots was greater in the cut areas.

[1] Published with the approval of the Director of the Wis. Agr. Exp. Sta. as a collaborator under North Central Regional Coop. Res. Project No. 10. Dept. of Agronomy, University of Wisconsin, Madison.

STUDIES OF EMBRYO DORMANCY IN PENNSYLVANIA SMARTWEED

Lucien J. LaCroix [1]

Pennsylvania smartweed under natural conditions produces seed which is extremely dormant. Furthermore, studies have shown that the dormancy is due primarily to metabolic or structural features of the embryo itself. Excised embryos, when placed on a basic medium containing the ordinary mineral salts, sucrose and agar, failed to germinate or occasionally produced plants that were dwarfed in appearance.

Attempts to attain embryo growth by the use of various media supplements failed. Reduced glutathione in the concentration range of 10^{-3} to 10^{-1} grams per liter and gibberellic acid in the range of 4×10^{-3} to 4×10^{-1} grams per liter did not stimulate embryo growth.

Germination tests on whole seed with varying environmental conditions were also studied. Cutting the seed coat failed to give increased germination of dormant seed. Elevated oxygen levels similarly had little effect, although some slight stimulation was observed at the 70% oxygen level.

The commonly used after-ripening procedure (pretreatment in moist vermiculite at 0° to 4°C for a month and a half) gave almost complete germination. Seed which had undergone such treatment is referred to as

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non-dormant seed in the discussion of cytological studies.

A preliminary survey of embryonic tissue was made by fixing isolated embryos from dormant and non-dormant seed in 3.1 alcohol-acetic, embedding in paraffin and sectioning with the conventional microtome. Phase-contrast and ordinary light microscope examination revealed the apparent absence of cell division, while all cells of the embryonic axis, with the exception of those of the vascular system, contained abundant accumulation of storage materials and few vacuoles. There was no apparent difference between dormant and non-dormant embryos.

Cellular fine structure was studied in more detail by techniques of electron microscopy. Material was fixed in buffered osmium tetroxide and embedded in vestopal or epon. Embryonic root cells of dormant seed contained large nucleoli of relatively uniform electron density, while similar cells of non-dormant embryos contained nucleoli with an accumulation of very electron dense particulate matter. These structures varied from 275 to 550°A in diameter and were observed also in lower concentrations in the nucleus and the cytoplasm.

The relatively high ribonucleic acid content of the nucleoli offers some foundation for a hypothesis that the after-ripening process in Pennsylvania smartweed follows a sequence whereby ribonucleic acid is synthesized in the nucleus, diffuses to the cytoplasm, then initiates the synthesis of enzyme systems required for subsequent germination.

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THE TRANSLOCATION AND METABOLISM OF 2,4-D AND 2,4,5-T IN WILD AND TAME CUCUMBER PLANTS

F. W. Slife [1], J. L. Key, S. Yamaguchi, and A. S. Crafts [2]

Most herbaceous plants react the same way to 2,4-D as to 2,4,5-T. A few, however, are more easily killed with 2,4,5-T. One such plant is wild cucumber (*Sicyous angulatus*). It is resistant to 2,4-D but easily killed with 2,4,5-T. Studies were undertaken to determine the nature of the resistance. Carboxyl labeled C^{14}, 2,4-D, and 2,4,5-T were applied to the leaf and through the root system of wild cucumber plants. Plants were harvested at 1, 4, and 8 days after treatment, freeze dried, mounted, and exposed to no-screen X-ray film. The developed autographs indicated that penetration and translocation of 2,4,-D was very good. This would indicate, then, that these factors are not involved in the resistance of this plant to 2,4-D. The penetration and translocation of 2,4,5-T appeared to be in much smaller quantities than the comparable series of 2,4-D. Another difference revealed by the autographs was that of redistribution. The 2,4,5-T treated plants seemed to redistribute the 2,4,5-T as the time series progressed while the 2,4-D pattern was approximately the same at the end of eight days as it was at the end of one day. This would indicate that the 2,4-D is fixed or tied up in an immobile form soon after translocation.

In another series of tests, plants were treated in the same manner and harvested at the same time intervals. Immediately after harvests, the plants were homogenized and extracts prepared for paper chromotography. The developed chromatograms showed that at the end of one day a very high percentage of the 2,4-D had already been converted to a conjugate while the 2,4,5-T was recovered as the free acid. Chromatograms of the 8-day plants revealed the same trend in that only a small fraction of free 2,4-D could be recovered while the 2,4,5-T was still primarily in the free acid form.

These studies indicated that the resistance of wild cucumber to 2,4-D could be due to the fact that 2,4-D is rapidly tied up and hence is not available to kill the plant. Since 2,4,5-T is not tied up, it can proceed to interrupt the plant's vital functions and eventually kill the plant.

The question raised in the study of the autographs regarding the lesser amount of 2,4,5-T in the wild cucumber plants was answered by further studies. When plants were treated with 2,4,5-T and treated spot removed, there was only a small amount of the total 2,4,5-T applied in the plant. When plants treated with 2,4,5-T were homogenized without removing the treated spot, almost all of the applied radio-activity could be accounted for. This indicates that only a small amount of the applied 2,4,5-T penetrated into the leaf, or, if it did penetrate, it did not move away from the treated spot.

This suggests the possibility that 2,4,5-T might be better than 2,4-D on some broadleaf plants if the penetrating qualities of the solution could be improved.

Tame cucumber plants were used as a comparison plant in all studies. The tame cucumber is easily killed with either 2,4-D or 2,4,5-T. In the autographs from tame cucumber, 2,4,5-T appeared to penetrate and translocate in smaller amounts than the 2,4-D. When chromatograms were prepared, the trend toward rapid tie up of the 2,4-D was evident but at a less rapid rate as compared to the wild cucumber. This could account for the fact that the tame cucumber is sensitive to 2,4-D.

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THE ACTION AND FATE OF DALAPON IN SUGAR BEETS AND YELLOW FOXTAIL[1]

R. N. Andersen, R. Behrens, and A. J. Linck

Studies were conducted in an attempt to find an explanation for the selective herbicidal action of dalapon. Sugar beets was the tolerant species and yellow foxtail was the susceptible species used.

Dalapon labeled with carbon-14 was used in studies on absorption and translocation using autoradiographic techniques. Later work in this study and the results of other workers would indicate that the radio-active compound responsible for the impressions on the autoradiographs was dalapon (or a salt of dalapon) *per se*. Radioactive dalapon entered and moved freely in both species following application to a leaf or to the roots. Dalapon appeared to accumulate most readily in the younger tissues of both species. These findings are in agreement with those for other species reported in the literature.

No metabolic derivatives of dalapon have been reported in dalapon-treated plants. The possibility of metabolic inactivation of dalapon was studied in sugar beets and yellow foxtail by employing dalapon labeled with C-14. Paper chromatographic separation of water extracts of shoots and autoradiographic methods for detecting radioactive spots on the chromatograms were used. No metabolic derivatives of dalapon were found in either species.

The effects of dalapon on the concentrations of various chemical constituents in sugar beets and yellow foxtail were studied in the hope that differential responses of the two species might offer some clue to the basis of selective action. Both species were treated in field plots with a post-emergence application of dalapon at a rate of 4 lb/A. Untreated plots were also included. Shoots were collected at 0, 1, 3, 6, 13, and 21 days after treatment. Free pantothenic acid concentrations in the shoots was determined by microbiological assay. Nitrogen in the shoots was determined by the

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Kjeldahl method and in the filtered expressed juice of the shoots by a micro-Kjeldahl method. Concentrations of two amides (asparagine and glutamine) and seven amino acids in the filtered expressed juice were determined by paper chromatographic separation and estimation from maximum density readings on a densitometer.

The free pantothenic acid concentration in the shoots of sugar beets was decreased 1 day after treatment. The free pantothenic acid concentration in the shoots of both species rose after 1 day following treatment.

Dalapon appeared to cause protein degradation in the shoots of both species. Proteins were broken down to amino acids. Further breakdown of free amino acids with the liberation of ammonia was indicated in both species. Striking increases in the concentration of amides (primarily glutamine in sugar beets and asparagine in yellow foxtail) following dalapon treatment indicated that the amides served as storage sites for the released ammonia in both species.

Visually observed recovery of the dalapon-treated sugar beet plants was accompanied by a general return of the concentrations of the various chemical constituents studied to levels near those found in untreated plants. Yellow foxtail plants did not recover after treatment and the concentrations of the various chemical constituents studied generally remained at much higher levels than in untreated plants.

The similarities in initial biochemical response of the two species and the fact that sugar beets recovered (as measured by visual appearance and biochemical determinations) may indicate that some mechanism capable of inactivating dalapon was operating in sugar beets. If such a mechanism were operating, our present knowledge would not support the conclusion that it was a metabolic mechanism.

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[1] Cooperative investigations of the Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, and the Minnesota Agricultural Experiment Station. Approved by the Director as Journal Series No. 4517.

[2] Respectively: Research Agronomist, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture; Associate Professor, Department of Agronomy and Plant Genetics; and Associate Professor, Department of Plant Pathology and Botany, University of Minnesota, St. Paul, Minnesota.

THE ENTRY OF HERBICIDES INTO SEEDS

D. A. Haskell and B. J. Rogers [1]

The technique of radioautography has undergone refinement in recent years. It is now possible, with suitable preparations, to produce what we like to call high-resolution micro-radioautographs. Under optimal conditions, for instance, various investigators have been able to show in *in situ* experiments the accumulation of thymine (one of the nitrogen bases found in desoxyribonucleic acid) in the individual chromosomes of cells.

The principal prerequisites are a suitable tritium-labeled chemical and a film emulsion which can be placed in direct contact with the cells to be examined. The tritium electrons emitted by radioactive decay are of such low energy that they travel only 1 or 2 microns. This means for all practical purposes only those tritium atoms directly below the film are recorded; the radiation which shoots off at an angle is absorbed by cell material before it gets to the film. In this way it is possible to achieve high resolution. The radiation from C-14 is almost 10 times as strong, and the resolution suffers a corresponding decrease.

As a crude illustration of this technique, we decided to examine the penetration of seeds by herbicides. The method used was as follows:

1. Seeds were soaked in water for varying periods of time (12 hours to 72 hours). They were then soaked in dilute solutions of a labeled herbicide for 3 hours, and then thoroughly rinsed in water.
2. A strip of film emulsion (Kodak AR 10) was placed on a clean glass slide to which water had been added. The seeds were cut through the middle and the cut surface laid downward on the film. The slide was immediately put into a petri dish which was resting on dry ice. The film and seed section were rapidly frozen into position.
3. The petri dishes were placed in light-tight boxes and left at 10°F for 1 to 2 months for exposure of the film. At the end of that time each film piece was developed by conventional means and placed wet on another glass slide, to which it stuck tightly. Pictures were then taken of the radioautographs.

Step 2 and the developing part of Step 3 had to be done in a darkroom by the light of a rather dim bulb. Needless to say, only larger seeds could be handled this way—we chose corn, soybean, and jimsonweed. The herbicides used were C-14 amitrole (donated by Amchem and Am. Cyanamid), C-14 simazine (donated by Geigy), and H-3 3-amino-2,5-dichlorobenzoic acid (donated by Amchem).

The results can be summarized briefly as follows: (1) after 48 hours soaking in water, corn seed had a high concentration of amitrole in the coleorhiza and cotyledon, a lesser amount in the epicotyl, and practically none in the endosperm; after 12 hours soaking in water amitrole had penetrated the entire soybean seed; there was very little, if any, amitrole in jimsonweed seed even after 72 hours in water; (2) after 48 hours in water, corn seed had some simazine in the radicle and epicotyl, and none, or very little, in the endosperm or cotyledon; after 12 hours in water soybean seed was thoroughly penetrated by simazine; there was no simazine in the jimsonweed seed at 72 hours; (3) Corn seed after 12 hours in water had no benzoic acid inside, after 24 hours there was chemical in the embryonic axis, and after 72 hours the herbicide had spread throughout the seed; in soybeans the benzoic acid herbicide had spread throughout the seed after 12 hours soaking in water; there was no penetration of the jimsonweed seed by the benzoic acid.

The corn was penetrated by the chemicals only a little at a time; the beans were rapidly penetrated by all of the chemicals, and the jimsonweed seed, which was in a dormant condition, was for the most part not penetrated.

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[1] Department of Botany and Plant Pathology, Purdue University.

THE GENUS CHENOPODIUM IN RELATION TO ENVIRONMENT

Bruce G. Cumming [1]

The purpose of these investigations is to determine some of the characteristics that enable a plant to act as a weed. We may then be able to influence such characteristics so that the plant is less able to germinate, grow, or reproduce. The North American continent provides an excellent field laboratory because of the range in latitude and longitude with the resultant diversity in daylengths, temperatures, nutritional and moisture levels. This is relevant in our attempt to define the physiological attributes contributing to the weediness of a species. In this laboratory we are studying the influence that light, temperature, nutrition and moisture exert on the processes of germination, growth, flowering and seed formation. Since these morphogenetic responses are the end expression of the basic physiology of the plant, we may gain further knowledge of some of the primary processes involved.

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Controlled environmental studies with selections of more than thirty species of *Chenopodium* support the postulation that the following may contribute significantly to the weediness or invasiveness of a species.

1. In the weedy species a proportion of the seed population has the ability to germinate under a wide range of environmental conditions. For example, the following four species, in order of distribution as weeds in Canada, would be evaluated as *C. album* > *C. glaucum* > *C. salinum* > *C. rubrum*. In *C. album*, a very weedy species, and *C. glaucum*, also a common weed although more restricted in distribution, some germination may be obtained at all temperatures between 10° and 35°C in light and darkness, whereas *C. salinum* and particularly *C. rubrum*, show much more specific requirements and may not germinate at all in darkness at constant temperatures. In weedy species, the occurrence of dormancy may be an important additional phenomenon, particularly if it prevents wasteful germination.

2. The weedy species have a potentially high rate of growth and the ability to flower and set seed fairly rapidly and abundantly under all daylengths—over a wide range of light intensities, temperature, nutritional and moisture levels. Thus, for example, although *C. album*, *C. glaucum*, *C. salinum*, and *C. rubrum* are all short day plants (SDP), that is, they flower most rapidly under short days (SD), the most selections of *C. album* and *C. glaucum* are capable of flowering fairly rapidly under long daylengths (LD). However, selections of *C. salinum* and particularly *C. rubrum*, flower much less rapidly under LD.

Under 16-hour LD, at constant temperatures of 12.5°C and 35°C, selections of *C. album* have shown the ability to flower and set seed quite rapidly, but, in contrast, *C. glaucum*, *C. salinum* and *C. rubrum* have shown a much reduced capacity to grow and reproduce.

3. In the major areas of Canadian agriculture, the majority of the annual weedy species of *Chenopodium* are SDP (Table 1); thus, the longer days of midsummer will tend to inhibit flowering, whereas the shorter days of autumn will tend to stimulate flowering and seed formation. Long-day annuals (LDP) will be the ones to flower most rapidly and plants will be small and less productive, in contrast to the SD annuals which will flower less rapidly and therefore produce larger plants, ultimately with greater production of seeds. Conversely, however, the biennial or perennial species of LDP which, if they overwinter, do so as a rosette of buds, flower in midsummer and then, if perennial, produce a further rosette in the autumn. These morphogenetic responses will coincide with the seasonal increase of daylength until mid-summer—which stimulates stem elongation and flowering—and later, the decrease of daylength into autumn which will favour rosette formation.

Table 1. Photoperiodic response as related to weediness: reaction of *Chenopodium* species to short and long daylengths.

	Annual species		Biennial-perennial species	
Distribution	SDP	LDP	SDP	LDP
Weedy	13	0	0	2
Non-weedy	12	3	0	3

4. The weedy species show high "phenotypic plasticity". This has been evaluated by studying the variation obtained in such morphological characteristics as minimum leaf number in response to different nutritional and moisture levels. For example, under SD, without nutrients, *C. rubrum* flowered with just 2 primary leaves, but with optimum nutrition, the number was still only about 4. In contrast, *C. album* when starved, flowered with 4-6 primary leaves, but with optimum nutrition, the primary leaf number was 20-30 (Table 2). Thus, the range in leaf number and other characteristics of growth and development was much greater in the weedy species. Such differences were even greater under LD (Table 2).

Table 2. Phenotypic plasticity: variation in leaf number on primary flowering stem according to daylength and nutrition.

	8-hr. short days		20 hr. long days	
Species	Starved	Nutrients	Starved	Nutrients
C. rubrum	2	2-4	-	-
C. salinum	2-4	2-4	-	50-60
C. glaucum	2-4	6-8	6-8	20-30
C. album	4-6	20-30	8-12	25-60

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PERSISTENCE AND DISTRIBUTION OF SIMAZINE APPLIED IN THE FIELD

Edward W. Stroube and Donald D. Bondarenko [1]

W-64 corn was planted in a Brookston silty clay loam (pH 6.4 and 6.3% organic matter) at Columbus, Ohio on May 25, 1959. Quadruplicate plots, 50 x 52.5 ft., were treated pre-emergence by simazine spray overall at 2, 4 and 8 lb/A in 80 gpa. A few perennial weeds emerged in the treated plots. These weeds and all weeds in the check plots were controlled by hand hoeing and shallow cultivation. The corn was harvested by hand. The stalks were shredded and all plots were disked immediately. The plots were split and the following crops were planted on the dates indicated: Dual wheat and Dayton barley - October 15, 1959; Clintland oats - April 18, 1960; W-64 corn - June 17, 1960; and Harosoy soybeans - June 20, 1960.

Table 1. Yield of crops following corn treated pre-emergence by simazine.

Simazine		Yield, bu/A				
lb/A		Corn	Wheat	Barley	Oats	Soybeans
0		78.2	50.9	78.1	95.1	33.2
2		79.6	51.8	81.0	86.7	33.0
4		79.4	28.9	39.8	48.7	21.5
8		83.2	4.0	15.3	10.5	9.1
LSD	0.05	NS	8.9	16.9	15.9	10.2
LSD	0.01	NS	12.8	24.3	22.8	14.6

The simazine treatment did not affect the yield of corn in 1959 and 1960. Simazine at 2 lb/A did not reduce the yield of any of the crops following corn. Simazine at 4 and 8 lb/A significantly reduced the yields. This residual effect was probably influenced by the relatively small amount of rainfall following the applications of simazine (Table 2).

Table 2. Rainfall at University Farm, Columbus, Ohio.

1959, inches							
May 25-31	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
0.98	0.96	3.10	0.94	1.53	2.83	3.31	2.42
1960, inches							
Jan.	Feb.	March	April	May	June	July	Aug.
2.36	2.95	1.00	2.15	5.03	3.74	5.30	4.00

Between May 25, 1959 and May 24, 1960, 27.85 inches of rainfall, approximately 10 inches less than normal, were recorded at University Farm.

Balbo rye was seeded August 1, 1960, on the oats, barley and wheat plots and Dual wheat was seeded October 12,1960, on the corn and soybean plots. Neither crop showed injury when observed December 3, 1960.

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In an attempt to determine quantitatively simazine residual in the field plots, samples of soil were taken from each plot on October 15, 1959, and May 12, 1960, and analyzed by bioassay using Clinton oats in the greenhouse. The soil was sampled at the 0- to 3-, 3- to 6- and 6- to 9-inch levels. The samples were replicated 3 times and 2 oat crops were grown in each soil sample. The second crop was planted one week after harvest of the first. The oat seedlings were harvested approximately 25 days after planting. Fresh weights were averaged for both crops (6 reps total, Tables 3 and 4).

Table 3. Fresh weight of oat seedlings grown in soil taken on October 15, 1959, from field plots treated by simazine on May 25, 1959. Yields were recorded for two successive crops (6 reps) and were expressed as percent of checks.

Simazine	Soil level, inches		
lb/A	0-3	3-6	6-9
0	100.0	100.0	100.0
2	45.2	49.1	109.9
4	11.0	26.9	117.4
8	5.3	22.7	112.6

Bioassay standards. Fresh weight of oat seedlings grown in soil treated by simazine thoroughly mixed in the soil and expressed as percent of checks.

Simazine, lb/A -	0	0.25	0.5	1.0	1.5	2.0	2.5
Percent of check -	100	41.6	15.6	12.4	10.8	6.7	5.5

Table 4. Fresh weight of oat seedlings grown in soil taken on May 12, 1960 from field plots treated by simazine on May 25, 1959. Yields were recorded for two successive crops (6 reps) and were expressed as percent of checks.

Simazine	Soil level, inches		
lb/A	0-3	3-6	6-9
0	100.0	100.0	100.0
2	107.3	110.0	99.6
4	26.8	75.6	106.8
8	6.0	8.7	89.5

Bioassay standards. Fresh weight of oat seedlings grown in soil treated by simazine thoroughly mixed in the soil and expressed as percent of checks.

Simazine, lb/A	0	0.125	0.25	0.5	1.0	1.5
Percent of check	100	68.3	36.2	11.7	9.5	6.0

After 5 months, approximately ¼ lb/A of simazine equivalent remained in the 0- to 3-inch and 3- to 6-inch levels and none in the 6- to 9-inch level in the plots treated by simazine at 2 lb/A as measured by the bioassay. Plots treated by simazine at 4 lb/A contained approximately 1½ lb/A simazine equivalent in the 0- to 3-inch level, 2/5 lb/A in the 3- to 6-inch level and none in the 6- to 9-inch level. Plots treated by simazine at 8 lb/A contained approximately 2½ lb/A simazine equivalent in the 0- to 3-inch level, 1/3 lb/A in the 3- to 6-inch level and none in the 6- to 9-inch level.

After 12 months, plots treated by simazine at 2 lb/A contained no residual simazine as measured by the bioassay. Plots treated by simazine at 4 lb/A contained approximately 1/3 lb/A simazine equivalent in the 0- to 3-inch level, 1/8 lb/A in the 3- to 6-inch level, and none in the 6- to 9-inch level. Plots treated by simazine at 8 lb/A contained approximately 1½ lb/A simazine equivalent in the 0- to 3-inch level, 1¼ lb/A in 3- to 6-inch level and 1/8 lb/A in the 6- to 9-inch level.

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VERIFICATION OF THE RELIABILITY OF A RAPID AND SIMPLE HERBICIDE EVALUATION PROCEDURE

P. C. Hamm and R. F. Husted [1 2]

In determining the growth inhibition or variation from normal obtained with a chemical pre-emergence spray a number of precise measurements can be obtained.

1. The number of emerging seedlings in a treated and untreated test pan can be counted and the per cent inhibition or control determined. This is rapid and simple.

It often happens that even though a large percentage of a given plant species may emerge through a chemical the plants are abnormal in either size or configuration or both. Such a condition reduces the validity of test procedure 1.

2. The weight of emerging seedlings at the end of a definite time interval may be obtained from a chemically treated and an untreated test pan and a per cent inhibition of normal growth obtained.

Cutting and weighing small samples of plant material is a slow, time-consuming operation. An analytical balance is required for the small samples.

3. A more rapid and simple yet valid measurement of chemical control of plant growth than a numerical green weight measurement was obtained in the following manner.

A. The number of emerging plants were counted as in (1) above.

B. A simple injury rating system of +, ++, and +++ was added to the rating dependent upon the degree of visual abnormality of the test plants.

+ = slight injury or abnormality.
++ = moderate injury or abnormality, i.e. 50/50 chance of survival.
+++ = severe injury or abnormality, one chance in four of survival.

For close comparative test evaluations a weighted numerical figure is obtained by simply dividing the number of emerging seedlings by a constant assigned to the injury ratings for treated and untreated plants. The per cent of normal is calculated as before. These constants are as follows:

Injury rating	Assigned constants
+	1.1
++	2.0
+++	4.0

To test the validity of this system the per cent control obtained with 8 pre-emergence test chemicals was determined by this means and also by cutting all emerged plants off at the ground level and obtaining the fresh weight of each sample on an analytical balance. The chemicals were evaluated at two different rates in triplicate.

The per cent control for each chemical formulation was calculated as follows:

$$\text{Percent control quick method} = 100 - \left(\frac{\text{Number of plants corrected for injury}}{\text{Number of plants in control}} \times 100 \right)$$

$$\text{Percent control weighing Method} = 100 - \left(\frac{\text{Weight of plants on treated pan}}{\text{Weight of plants in control}} \times 100 \right)$$

The weighing procedure required 12 man hours to obtain the data. The visual injury rating procedure required about one man hour.

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The average results obtained by both methods for all formulations were as follows:

Rate lb/A	Percent control Quick method	Weighing method
0.15	28.4	26.1
0.3	67.3	72.0

These averages indicate good agreement of the two methods as measures of the same value. A statistical analysis of the data further confirmed the agreement of the two methods. The results were as follows:

Significance level	LSD* Quick method	LSD* Weighing method
80	0.145	0.104
90	0.199	0.143
95	0.260	0.186
Standard deviation	0.1146	0.08225

*Expressed as the $\log_{10}$ of the percent control

These data indicate that the average values obtained by the two methods are measures of the same value. The quick method is not quite as sensitive as the weighing method but requires only one-twelfth the time. The quick method is more than adequate and is a valid procedure for evaluating the herbicidal activity of a preemergence chemical.

[1] Monsanto Chemical Company, Agricultural Chemicals Division, Research Department, St. Louis, Mo.

[2] The help of D. B. MacKenzie and J. H. Nolan in preparing the herbicidal tests is greatfully acknowledged.

BARBAN (CARBYNE) FOR WILD OAT CONTROL

H. E. Bingham[1]

Carbyne post-emergence herbicide is an emulsifiable concentrate containing one pound active ingredient (barban) per gallon. Its principal use to date is in the area of controlling the severe competition of wild oats in spring wheat, durum, barley and sugar beets. In 1960 it was sold on an experimental basis and on a controlled field development program. Our presentation will be in three parts, first the 1960 farmer results, secondly the 1960 research and experimental results and thirdly our thinking for 1961 use which includes new crops such as peas, flax, safflower, sunflower, and rape.

Evaluation of the 1960 farm trials has been completed. It reveals that over 850 farmers in the U. S. and 1250 farmers in Canada bought and used Carbyne. They were sold only enough product to spray not more than 20 acres on the grain crops. A complete case history of application, growing conditions and results was maintained by the field worker and attested to by the user. A review of these case histories reveal that 92% of the users indicated satisfaction. The remainder were not satisfied either because of temporary stunting of grain or mistiming or misapplication. Samples were taken from check and treated areas on a five paired quadrat sample basis. A few combined samples were taken on grain. The 447 farms sampled indicate an average yield increase of 9.2 bushels per acre on spring wheat, 9.9 bushels increase on durum, and 10.2 bushels increase on barley. No decreased yields were noted on sugar beets, however, production costs were reduced considerably. In some cases complete areas were saved from plowing and reseeding. Grains generally were treated at the 1960 recommended rate of ½ pound active or ½ gallon Carbyne per acre at a spray solution rate of 5 gallons per acre. Sugar beets were band sprayed at the rate of 1 gallon of Carbyne per acre actually sprayed. A few farmers cut the rate below recommendations and received satisfactory results. This rate on grain varied to dosages somewhat below the ½ gallon rate per acre. The rate on sugar beets remained constant, one gallon or one pound active per acre. Some fields showed initial stunting on some varieties of wheat and barley at the ½ gallon rate. However, almost without exception these crops recovered, particularly where good fertility and crop population was present.

Our experimental work in 1960 with Colleges, Universities and Experimental Stations in addition to plots put out by personnel from Spencer Chemical Company's Research Center was again large in scope. Additional work on spring wheat, durum, spring barley and sugar beets was continued. Accelerated work was accomplished on flax, safflower, peas, rape, sunflower and mustard. The results of this experimental work reflect the following:

1. Rates lower than ½ pound per acre are satisfactory on field crops.
2. It is an unusual situation when a full pound per acre is required on any crop.
3. The fan, hollow cone and twin flow nozzle give the same significant results. It is very apparent that a trend to better results was obtained when the fan type nozzle was directed forward at a 45° angle as compared to the perpendicular or 90° angle.
4. Pressures of 45, 60 and 90 pounds gave no improved results over the 45 pounds used in the field in 1960.
5. Water gallonage experiments dictate no change in our previous recommendations.
6. Noted effects on wild buckwheat, tartary buckwheat, curled dock, ladysthumb and smartweed were seen in the field. No data are available that would lead us to recommend Carbyne on these weeds for 1961.
7. When, experimentally, MCPA and Carbyne were sprayed at the same time, results were sufficiently good when the MCPA dosage did not exceed the Carbyne dosage. The use of 2,4-D would be too early to use on crops recommended for 2,4-D as damage would result. We can not recommend this practice until further results are obtained.
8. Following three years of ground type application, we experimented with air application in 1960. Recognizing different conditions we supervised air applications in 17 locations in North Dakota. Our summary tells us that there is more work to do. Air application just now is only a substitute for ground application, however, if it becomes a choice of plowing up and reseeding a field or using air application we believe it would be an economical move on the farmer's part to use air only if he can not apply by ground due to wet condition of the fields.
9. Some research and extension people have experimented with Carbyne wherein they control volunteer rye in wheat and barley. We are very much interested in their efforts thus far and will continue to assist them.
10. College people have been testing Carbyne on winter wheat and winter barley varieties. Further field work is required in this area.

With this background and solid foundation of experimental work let us look into the future. First we shall comment on the recommendations for Canada. On spring wheat, durum, barley, field and canning peas, rape and flax, the dosage is 5.1 oz. to 7.2 oz. barban or 2⅛ pints to 3 pints Carbyne per acre. On sugar beets, the dosage is 8.1 oz. to 12 oz. barban or 3⅜ pints to 5 pints of Carbyne per acre. Flax is recommended for experimental use only in 1961 and we shall limit acreage sprayed. The can will contain 4 Imperial gallons in Canada. One can will service a minimum of 15 acres of wheat, barley, peas, rape and flax when applied at the lower rate (5.1 oz. barban) in 4 Imperial gallons of spray solution (Carbyne and water). On sugar beets one can will service a minimum of 10 acres by using the lower rate (8.1 oz. barban) 3⅜ pints Carbyne when spraying overall. The use of band spraying techniques on sugar beets will increase the acreage treated proportionately

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according to the width of the band sprayed. Pressure must be a minimum of 45 pounds. Tee Jet nozzle 650067 or 730077 Monarch 20 or 22 fan type or their equivalent is recommended. Also the Tee Jet X-4 and Monarch F-97-6.4 hollow cone or their equivalent is recommended for overall spraying. Preparing the sprayer for use is second in importance only to time of spraying. We found sprayers last year in a pretty poor condition—scale in tanks, last years material in tanks, corroded lines plugging free flow and nozzles of the right markings but in no shape to use. In calibrating some two thousand sprayers last year our men showed some farmers why they had been getting poor results with other chemicals. Does he, the farmer, operate any of his other equipment in this condition? We are at fault in not emphasizing the efficiency gained by a good operating sprayer. You industrial men, how long do you allow a machine to operate inefficiently in your work?

Winds up to 15 m.p.h. are acceptable. Rain following a spray operation will not reduce the activity of Carbyne, however, plants must be dry before spraying. The range of dosage in Canada is believed necessary by some to take care of very heavy infestations of wild oats.

Time of spraying is all important. We still recommend that the wild oats be sprayed when the majority of them are in the two leaf stage. This is when the second leaf first appears until the third leaf first appears which is usually four to nine days after emergence. Under conditions of low fertility and moisture or unusually cold weather the leaf will not develop as rapidly as the seed head itself. Carbyne affects the maturity of the seed head, therefore if the leaf growth has not reached the two leaf stage we recommend that wild oats be sprayed before the fourteenth day as the seed head is growing but not showing. Also we have noted that the age of wheat and barley is important. Spraying done when these crops are in the fourth leaf stage or older will result in some stunting of the crop. This should be avoided.

Complete kill will be noted in a very few instances as the wild oats will not always be in the critical leaf stage to cause complete kill. However, it has been noted in most all cases the wild oats not eradicated will be greatly stunted in height and only a very few seeds will develop on the stunted wild oat plants. This materially reduces the seeds returning to the soil and the dockage hauled to the elevator.

Let it be clearly understood that Carbyne is not a substitute for good cultural practices. It is a tool for the farmer to use in supplmenting his good farm management. Healthy crop population together with Carbyne will mean victory over wild oats.

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2,3-DICHLOROALLYL DIISOPROPYLTHIOLCARBAMATE (AVADEX) IN THE UNITED STATES

L. H. Hannah[1], G. W. Selleck[1] and R. E. Althaus[1]

Concurrent with commercial sales of Avadex[2] in Canada, development plots were established in cooperation with growers using their equipment at some 70 locations in the wild oat areas of the United States from Minnesota to California. Various rates were applied to plots a minimum of 1-acre in size at 35 of these locations.

The crops flax, sugar beets, safflower, peas and lentils were found to be tolerant to Avadex at rates in excess of 2 lb/A. There is evidence, however, that thinning of sugar beets may occur on coarse textured soils at this rate. Barley and durum wheat are tolerant to Avadex at 1¼ lb/A when care is taken in the method of incorporation.

Avadex appears to be less influenced by environmental conditions than was previously thought and it has been found in the evaluation program that incorporation of the chemical into the soil is important to the optimum performance of Avadex. A disk implement, spring-tooth harrow, or field cultivator plus a spike-tooth harrow, may be used for this operation. The method of incorporation is not important as long as Avadex is thoroughly mixed into the soil at a maximum depth of 2 inches immediately following spraying. At three locations in North Dakota and Minnesota, incorporation with a cultivator followed by a harrow provided equivalent control of incorporation with a disk implement. In the pea growing areas of Washington and Idaho where the spring-tooth harrow is usually employed in seed bed preparation, a single mixing of chemical after spraying usually leaves streaks of wild oats. A second incorporation made at right angles gave complete coverage of the chemical which resulted in excellent wild oat control.

When incorporation has been shallow, it has been noted in several cases that the 1½ lb. rate has caused little or no wheat damage. However, with deeper incorporation, and the crop seeded into the treated area, severe stand reduction generally occurred. This was substantiated by work in the laboratory where deeper incorporation resulted in reduced wild oat control and increased thinning of grain crops. In these studies Avadex effectively inhibited all wild oat germination and growth at soil concentrations of 0.23 ppm (96%) and above. It was fairly effective at concentrations as low as 0.175 ppm (69%). Wheat (average of 3 varieties—Selkirk, Thatcher, Pembina) was critically injured (59%) at soil concentrations of 0.35 and above. Wild oats are killed when only the coleoptile contacts the herbicide, while contact by the radicle appears necessary for wheat injury. Wheat survived excessive concentrations of Avadex if the crop was seeded below the treated zone.

Wherever Avadex has been applied and incorporated properly in wild oat infestations, substantial yield increases have resulted. As Avadex is not capable of controlling seedlings at the time of spraying, all applications should be made prior to emergence. This has the added advantage of permitting the grower to sow his crops at the optimum date for maximum crop yield. At Mahnomen, Minnesota, barley yielded 46 bu/A at the 1½ lb/A rate compared with 12 bu/A in the check. Similar results were obtained at Jamestown and Park River, North Dakota. Durum wheat at Devils Lake, North Dakota yielded between 24 and 25 bu/A at the 1.25 to 1.75 lb/A rate compared with 18 bu/A in the check. In flax, wild oat control varied from 85 to 99% at rates from 1 to 2 lb/A. Rates of Avadex may be decreased for wild oat control in good competing crops such as wheat or barley. Where green foxtail or wild millet is a problem in sugar beets and flax, rates in excess of 1½ lb/A will provide moderate to good control.

In Washington an increase of 965 lb of green peas was obtained where Avadex had been applied at the rate of 1½ lb. Dry peas and lentils grown in the same area responded in a similar manner. Where Avadex has been used in sugar beets, from $10 to $25/A was saved in hand weeding and thinning costs. Increased yields up to 1½ tons/A of sugar beets have not been uncommon.

Results were similar to those in Canada with the respect that air applications were slightly less effective than ground applications. Either water or diesel fuel could be used as a carrier for Avadex and volumes of water ranging between 1½ to 35 gal/A did not significantly affect the degree of control. At Cut Bank, Montana, 13 acres of wheat were treated using 1½ lb of Avadex in 1½ gal of water. Excellent wild oat control was obtained with no thinning of the crop.

Residue studies have been conducted to comply with the requirements of the FDA in the United States. Analysis shows that the herbicide does not exist in ma-

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ture plants of barley, flax, wheat, peas or sugar beets that have been harvested from plots treated with rates as high as 6 lb/A. The herbicide is now registered in the United States on a "no residue" basis.

[1] Monsanto Chemical Company, St. Louis, Missouri.
[2] Trademark Monsanto Chemical Company, Reg. U.S. Pat. Off.

WILD OAT CONTROL WITH 2,3-DICHLOROALLYL DIISOPROPYLTHIOLCARBAMATE IN CANADA, 1960.

G. W. Selleck[1]

To supplement studies conducted by Experimental Farms and Universities, Monsanto applied Avadex (2,3-dichloroallyl diisopropylthiolcarbamate) to 139 1-acre plots adjacent to 113 check plots at 8 locations in Saskatchewan, Canada. It was the purpose of these trials to determine the performance of Avadex in different crops, in various environments, and under different conditions of spraying and incorporation. Applications were made in cooperation with farmers, using their equipment.

These data were supplemented by commercial applications at rates between 1 and 2 lb/A in western Canada during 1960. Of the total treated acreage, 118 fields involving 3304 acres of flax, 518 of barley, 535 of wheat, 215 of sugar beets, and 180 acres of rapeseed were inspected at random. More than 85% wild oat control was obtained on 89% of the fields, between 75 and 85% on 7% of the fields and 75% or less on 4% of them.

Sugar beets, peas, rapeseed, sunflowers and forage leugmes are tolerant to Avadex at rates in excess of 2 lb/A. In one of Monsanto's trials at Nipawin, Sask., red clover flourished at rates where barley was completely killed. Barley is usually unaffected at 1½ lb/A but stands are occasionally thinned on fine-textured soils. Some thinning has occurred also in stands of wheat at 1 lb/A. However, in the Rosetown district, where one stand was initially reported as decreased by 30% at 1½ lb/A, wheat treated with Avadex out-yielded the checks by more than 10 bu/A. In another field, Avadex at 1 lb/A controlled wild oats approximately 75% on 165 acres of wheat, which yielded 23 bu/A as an alternate to a "second summerfallow." Carder at Beaverlodge obtained an increase of 25% in barley yields with Avadex at 1 lb/A and Forsberg at Scott more than doubled flax yields with the use of Avadex. Because wheat and barley are highly competitive, rates as low as 1 to 1¼ lb/A were usually effective for wild oat control in these crops.

Work at several Experimental Stations in western Canada has shown that Avadex performs better on coarse-textured as opposed to fine-textured soils. With proper incorporation, however, good wild oat control can be obtained on fine-textured soils with rates as low as 1 lb/A (Table 1).

Table 1. The % control of wild oats with Avadex in Saskatchewan as a result of variation in methods of incorporation.

	Silty clay loam		Loam		Heavy clay	
Rate lb/A	Disker + harrow	Harrowed twice	Cultivator + harrow	Double Disked	Dis-kered twice	Dis-kered once
1.00	75	55	95	95	92	85
1.25	85	75	95	95	94	92
1.50	95	95	99	99	95	96
1.75	99	95	99	95	95	95
2.00	99	95	99	95	99	99

It is more difficult to obtain consistently good control on clay soils because they are harder to work. Wild oat control is less effective on a soil which is lumpy, wet, or in poor tilth.

Any implement which efficiently mixes the soil is adequate for incorporation (Table 1). Shallow incorporation (by avoiding dosage dilution and treatment of soil in the seed zone) is most effective for wild oat control and for minimizing the risk of faulty crop germination. Shallow tillage is also more effective in controlling "late germinating" wild oats. In northern Saskatchewan, wild oats germinated until approximately July 30. Fields which were incorporated as shallow as possible more effectively controlled these "late germinators" because of the concentration of the chemical nearer the soil surface.

There is good evidence that heavy rain immediately after application precludes the necessity of incorporation at the time of application.

The plow is not an effective implement for incorporation since it effectively buries the herbicide, leaving untreated soil at the surface. For those who wish to use a plow and a pony-press drill, the application may be made after seeding.

Evaporation of Avadex from the soil surface is substantially increased in high wind velocities. At Riceton, Saskatchewan, in a field of flax, wild oats were controlled 95% when applied to a 10 mph wind and 25% when applied to a 30 to 50 mph wind.

Delayed incorporation has resulted in less effective control in several Saskatchewan trials. At Riceton, control was 95% with incorporation the same day compared with 50% with incorporation delayed by 4 days. This has been substantiated in the laboratory[2] where 36% of the Avadex evaporated from the soil surface within 24 hours, 30% within 8 hours and 20% within 3 hours.

The results of field trials have suggested that Avadex performs more efficiently on dry soil than on moist soil. Work in the laboratory[2] has shown that this loss is more rapid from moist soil.

The fact that high wind velocities decrease the efficiency of Avadex and that immediate incorporation improves it, suggests the efficiency of spraying and incorporating in one operation. Such an implement with the boom mounted a few inches from the ground would solve both problems. One commercial operator in Saskatchewan applied Avadex to a field which was obviously too wet for effective incorporation. He mounted a sprayer boom on a chisel-tooth cultivator and with shallow tillage at 7 mph succeeded in incorporating Avadex into the wet soil. The 1½ lb/A rate provided virtually 100% control in flax.

The carrier for Avadex is not a consideration of vital importance. Good wild oat control has been obtained in water volumes from 4 to 11 gal/A. Diesel fuel may be used also from 1 to 4 gal/A. In general, air applications are slightly less effective than ground applications, probably because of increased evaporation during application.

[1] Monsanto Chemical Company, St. Louis, Missouri.
[2] Dr. John Deming, Monsanto Chemical Co. (Unpublished data)

GROWER ACCEPTANCE OF GRANULAR HERBICIDES

Earl C. Spurrier[1]

The acceptance of granular herbicides has been one of the more dramatic recent developments in the herbicide field. The interest in this concept of application is nationwide and perhaps stems from the successful use of granular forms of soil and surface insecticides.

More recently, following the successful use of granular DDT for corn borer and mosquito control, granular aldrin, heptachlor and others for soil insect control, the very successful use of granular insecticides for fire ant control and other successful granular insecticide programs, we are faced with high farmer and grower interest in granular herbicides. Since 1958, chemical sup-

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pliers have increased activity in evaluating granular formulations of various herbicides. Brush control, aquatic weed control, pre-emergence weed control and industrial soil sterilization all are areas of intensive investigation for considering the possible merits of the feasibility and practicability of the granular method.

Of more significance presently is the acceptance of the granular pre-emergence concept. Research workers at experiment stations in nearly every area of the country are now accumulating data regarding the comparative performance of the various chemicals in spray and granular forms.

In 1959, granular 2,4-D, EPTC, CDAA, CIPC, simazine, and several other pre-emergence chemicals were marketed commercially in volume. At the same time extensive field testing was in progress for many other proprietary items. By 1960, the full impact of the granular concept was being felt in the Corn Belt. No less than ten chemical companies were marketing 2,4-D granules in 1960. Granular CDAA, CDAA + trichlorobenzyl chloride (Randox T)[2], CDEC, simazine, atrazine, dinitros, CIPC, endothal, EPTC and others were marketed at commercial quantities in the United States. Volume was in millions of pounds of product.

Two years of commercial experience supplying particular forms of several widely used herbicides indicate that many farmers and growers desire to use a granular formulation where feasible and practical. This report essentially is a progress report that will give some indication of the field acceptance of a few granular herbicides.

Today, we will elaborate on granular pre-emergence herbicides, particularly CDAA, Randox T, CDEC and 2,4-D and ensuing trends of adaptation of the concept. Although precise figures are difficult to obtain, the trends are relatively accurate and will demonstrate the growing interest in this field.

It was not until about 1958 that the pre-emergence concept began to really catch on to any extent in the Corn Belt and many other areas. At this time granular 2,4-D began to receive greater attention commercially. Also certain experiment stations began to report on the comparative effectiveness of liquid and granular formulations. Early Monsanto evaluation indicated that CDAA and CDEC in granular form were similar to the liquid formulation with respect to herbicidal activity. Since then many experiment stations have confirmed these reports. Commercial experience with CDAA and CDEC in 1959 and 1960 have further supported the experiment station conclusions.

Inherent chemical characteristics of CDAA, Randox T, and CDEC allow for highly concentrated granular formulations—20%, 35%, and 20% respectively. These herbicides are generally impregnated on Attapulgite clay type inerts. Inert carriers meeting certain specifications are utilized to permit optimum herbicide release and effectiveness while maintaining granular quality and durability for field use.

Although CDAA, Randox T, and CDEC products are and will be available as liquid formulations for use with presently used field spray equipment, it appears that many users show preference to granules for the following reasons: 1) the handling characteristics for CDAA and Randox T are improved. 2) Water hauling is eliminated. 3) Time is saved. 4) Less labor is required. 5) Mixing errors are eliminated as granules are premixed. 6) There is less total weight on equipment and 7) Post-transplant applications are more practical with less chemical contact with foliage.

The introduction of CDAA granules on the market in 1959 created a very interesting acceptance pattern. Although early sales predictions and market forecasts were rather bearish, almost overnight the demand for immediate supplies of the product caused production schedules to be altered on five different occasions with several hundred-fold increases in quantities. Production schedules could not meet the demand in the Corn Belt area. Post-emergence applications of CDAA granules for weed control in onion production areas became common practice. Today repeat applications of CDAA on onions are almost entirely with granular formulations. Field performance of the granules was extremely satisfactory under many widely differing field conditions.

In 1960, the demand for the granular forms of these products resulted in the disappearance of almost 800 percent more than in 1959. Sales of granular Randox T would have been much higher but supplies were exhausted before the season reached its peak. It is anticipated that much larger quantities of these products will move in the granular forms in 1961. The field performance of these granular products in 1960 was quite satisfactory and in most cases excellent. Granular CDEC, for instance, has performed more consistently than liquids in many areas.

The acceptance of granular forms of pre-emergence herbicides and granular applicators is very closely correlated. Marked improvements are now apparent in both product areas. The equipment improvements are in forms of stronger mounts, improved metering systems and refinements to improve delivery and uniformity of application. In 1958, 1959 and 1960 there were one, two and three equipment companies respectively supplying granular equipment in the Corn Belt area. In 1961, there will be about nine or more different companies with equipment for granular application available for row crop use. Each is anticipating good sales movement. It is estimated that about 100,000 or more pieces of equipment for row crop application should be available for use in the Corn Belt area in 1961 for herbicide use alone.

Granular herbicides appeal to farmers. They are extremely receptive to the idea and indicate a willingness to pay the slightly higher cost for materials and equipment. This in part is justified by savings in time and ease of application. The future of this concept is very promising. It should be the challenge and responsibility of research-minded individuals and chemical suppliers to thoroughly investigate the many facets of any problems involved—and there are a few—but remember the idea is relatively new. Efforts to improve both product knowledge and equipment are necessary.

[1] Monsanto Chemical Co., St. Louis, Mo.
[2] Trademark of Monsanto Chemical Company, Reg. U. S. Pat. Off.

PROGRESS REPORT ON AMIBEN

Dale A. Bush[1]

In 1957, limited greenhouse and field studies were conducted with amiben (3-amino-2,5-dichlorobenzoic acid). From these early studies it was learned that amiben was active as a pre-emergence material. During the following years—1958, 1959, and 1960, more extensive field trials were established to test amiben throughout the North Central States and Central Canadian area. These tests demonstrated the efficiency of the product as a selective herbicide in soybeans as well as in other agronomic and horticultural crops for the control of most annual broadleaf weeds and grasses.

In 1960, over 200 extension plots were established in soybeans. Aside from the extension program, 42 other cooperators including university research specialists, state sub-stations, foundation seed personnel, and certified soybean producers have tested amiben.

The three years of widespread and extensive testing of both a liquid and a granular formulation for pre-emergence application have established the characteristics of amiben as an herbicide.

Pre-emergence control of both annual grasses and broadleaf weeds has been good at rates as low as 1 lb/A for a period of three weeks to one month when moisture followed application. At 2 lb/A, weed control has been very good even without cultivation. With ½ to 1 inch rainfall the first week to ten days after application, 3 lb/A and upward have given essentially complete con-

trol of weeds throughout the season without cultivation. With one lay-by cultivation, tests show no difference between 2 and 6 lb/A. Where soybeans have been planted with good surface moisture and followed by a prolonged dry condition, even rates as high as 8 lb/A have not given satisfactory weed control, possibly because of the inability of the herbicide to penetrate to the root zone were moisture is available for weed seeds to germinate. However, on the other hand, if the top 1 to 1½ inches of surface soil where most annual weeds germinate is dry at planting time, followed by the same dry conditions, 3 lb/A amiben has given satisfactory weed control after it rained.

Tests show that 3 lb/A has given uniformly good weed control in a wide variety of soil types. At this rate, no apparent difference in weed control resulted from its use on silty loam, silty clay loam, clay loam, sandy clay loam, or sandy loam soils. However, control ratings fell off slightly on peat or muck and heavy gumbo soils.

At least thirty varieties of soybeans have received applications of amiben with no apparent differences in tolerance. However, with certain soil types and rainfall levels there may be a slight stunting, which is usually temporary, the beans regaining normal growth and size after four to six weeks. It is evident from several tests that there has been no reduction in bean yield from this stunting, even at 6 to 8 lb/A.

In general, 3 lb/A amiben will control most annual and perennial weed seedlings. However, occasionally three weed species—cocklebur, jimsonweed, and ivyleaf morning glory, have appeared in treated areas. It may be that they are germinating from a depth at or below that of the soybeans, while the herbicide is remaining in the upper soil surface.

Post-emergence applications of amiben to weeds and soybeans have shown some promise of weed control without injury to soybeans.

Studies made where high rates of amiben were used indicate that very little carry-over or residual effect resulted one year after applications under 16 lb/A.

From 81 soybean extension reports covering six states, it is apparent that the standard rate of 3 lb/A the effectiveness of the granular formulation is equivalent to that of the liquid formulation. Percentage of "good", "fair" and "poor" weed control ratings in the 81 extension trials were as follows:

Annual grasses		Annual broadleaf weeds	
Good	77%	Good	74%
Fair	15%	Fair	18%
Poor	8%	Poor	8%

Considerable interest in narrow row spacing of soybeans has developed. In one test where soybeans were planted in 40-inch rows and had two cultivations the yield was 32.8 bu/A. In comparison, 40-inch rows treated pre-emergence with 2 lb/A amiben and no cultivation yielded 33 bu/A; 20-inch rows with double the seeding rate treated wtih 2 lb/A amiben and no cultivation yielded 41.1 bu/A.

Other crops on which amiben has shown promise with crop tolerance and weed control are: lima beans, cowpeas, peanuts, flax, carrots, parsley, parsnips, squash and pumpkin, transplanted tomatoes, and sweetclover.

Progress is being made on residue studies. With the present information a full label for the use of amiben on soybeans grown for seed has been approved by the USDA. Soybean seed samples have been furnished by a number of weed specialists in the Midwest and these samples will be analyzed for amiben as soon as the chemical procedure is perfected. A procedure is available for analysis of amiben in soil. We hope to complete the soybean testing in the next few months and move on to analysis of amiben in other crops.

[1] Amchem Products, Inc., Ambler, Pa.

WEED CONTROL IN SOYBEANS AS INFLUENCED BY ROW SPACINGS, CHEMICALS, AND CULTIVATIONS

Elroy J. Peters and Frank S. Davis[1]

The better pre-emergence herbicides generally control weeds until soybeans provide enough shade to eliminate many late-germinating weeds. Under these conditions cultivations are necessary only to control weeds between the rows which the soybeans fail to eliminate. Soybeans in 20-inch rows provide a canopy that completely covers the soil much sooner than those planted in 40-inch rows; thus the narrow rows may have fewer weeds and require fewer cultivations than the wide rows. This experiment was performed on Mexico silt loam in 1958 and 1959 and on Putman silt loam in 1960. Twenty-inch rows were compared with 40-inch rows to determine the number of cultivations necessary to produce maximum yields of Clark soybeans. The experiment was laid out as a factorial design with the following treatments applied to each row spacing: (a) 3 cultivations; (b) 20 lb/A of sodium salt of PCP and 0 cultivations; (c) 20 lb/A sodium salt of PCP and 1 cultivation and (d) 20 lb/A of sodium salt of PCP and 2 cultivations. Each plot was 30 ft long with three 40-inch rows or five 20-inch rows. The planting rate was approximately the same per acre for each spacing. In 1960, amiben at 3 lb/A was included and plots were cultivated 0, 1, or 2 times as with PCP. The herbicides were applied pre-emergence in 40 gpa water. The treatments were evaluated by obtaining the yields of soybeans and weeds from a 30-foot row of each plot. Soybeans planted in 20-inch rows generally produced higher yields of soybeans and lower yields of weeds than when planted in 40-inch rows. Increasing the number of cultivations tended to reduce yields of soybeans in some cases indicating that some injury may occur from cultivation. This reduction in yield with increasing numbers of cultivation occurred most often in 20-inch rows indicating that perhaps only 1 cultivation can advantageously be given narrow rows. Increased yields of soybeans from cultivations were probably due to removal of weeds in most cases, but in some cases where weeds were well controlled chemically there was some indication that tillage occasionally was beneficial for reasons other than weed control. Herbicides were usually beneficial in reducing the amount of weeds and increasing soybean yields. The highest yields usually occurred in 20-inch rows with herbicide treatments which were cultivated once.

[1] Research Agronomists, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, Columbia, Missouri. Cooperative investigations of the Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture and the Missouri Agricultural Experiment Station.

EFFECTS OF HERBICIDE TREATMENT, ROW SPACING, AND CULTIVATION ON WEED CONTROL AND YIELD OF GRAIN SORGHUM

Ronald E. Talbert and O. Hale Fletchall[1]

Grain sorghum has in recent years become an increasingly important crop in Missouri agriculture. Very little research concerning cultural practices in growing this crop has been done in Missouri. In other studies, increased weed control has been observed to result from planting grain sorghum in narrow spaced rows instead of the conventional 40-inch row spacing. If early weeds could be controlled by using a satisfactory pre-emergence herbicide, and the later weeds by decreased row width,

the need for cultivation as a weed control measure could be largely eliminated.

Experiments were conducted in 1958, 1959, and 1960 which included the following variables: (a) 8-, 20-, and 40-inch rows, (b) treated pre-emergence with 2 pounds per acre of neburon and untreated, and (c) cultivated none, one, two, or three times in the case of 20- and 40-inch rows. The 8-inch rows were not cultivated. The cultivations omitted in each case were the earlier ones. The resulting eighteen treatments were arranged in a randomized complete block design with four replications each year. These studies were conducted near Columbia on Mexico silt loam. The average stands obtained were: 80,000 in 8-inch rows, 60,000 in the 20-inch rows, and 40,000 in the 40-inch rows. Data were obtained each year on the yield per acre of broadleaved and grass weeds, and sorghum grain and stover.

In 1958, the main weed problem was annual broadleaved weeds. Rain occurred soon after the pre-emergence treatment with neburon, making this treatment very effective in reducing weed growth and increasing sorghum yields. In 1959, it remained dry for several weeks after planting and treatment. This resulted in a less severe weed problem, but the neburon was ineffective in controlling the weeds which were present. In 1960, neburon treatments resulted in average control of fall panicum, the dominant weed species that year.

The average results from the various treatments for the three years are shown in Tables 1 and 2. Under

Table 1. Pounds of weeds per acre as affected by herbicide treatment, cultivations, and spacing (1958, '59, '60 averages).

Herbicide	Number	Row spacing (inches)		
treatment	cultivations	8	20	40
None	0	3000	3000	4600
	1		2500	2100
	2		1400	1600
	3		1600	1700
Neburon	0	1000	1600	2300
	1		1400	500
	2		800	300
	3		500	500

Table 2. Bushels of sorghum grain per acre as affected by herbicide treatment, cultivations and spacing (1958, '59, '60 averages).

Herbicide	Number	Row spacing (inches)		
treatment	cultivations	8	20	40
None	0	41	36	20
	1		40	37
	2		54	51
	3		60	52
Neburon	0	62	55	49
	1		58	63
	2		67	62
	3		72	65

uncultivated conditions, decreasing the row spacing from 40 to 20 inches and from 20 to 8 inches resulted in dedecreased weed growth and increased yields of sorghum grain. Yields of sorghum stover also were increased in response to the narrower row spacings. The narrower rows with thicker stands and more uniform spacing between plants evidently led to more efficient utilization of available water, light, and nutrients, and the sorghum crop was more competitive. Weed grass growth tended to decrease wtih decreases in row spacing. Decreasing row widths did not materially reduce broadleaved weed growth possibly because of the earlier and taller growth of these weed species as compared to the grasses. In these studies, no attempt was made to separate the effects of increased stand from the effects of decreased row width. In 1958 studies, there was less tendency for yield increases to result from narrow row spacings. This may have been due to less differences between sorghum stands within the various row widths that year than in 1959 and 1960.

In the 20-inch rows, cultivation was difficult and not nearly as effective as in the 40-inch rows (Table 1). Three cultivations of 20-inch rows were required to equal the additional weed control obtained from one cultivation of 40-inch rows where neburon was used in both. Where neburon was used on drilled rows of sorghum, yields of grain were about the same as in 40-inch rows which had received cultivation. However, the drilled plots were more weedy than the cultivated 40-inch-row plots.

[1] Instructor, and Associate Professor of Field Crops, University of Missouri.

PERFORMANCE OF ENDOTHAL AS A SELECTIVE HERBICIDE FOR SUGAR BEETS

Russell T. Nelson[1]

Endothal has now been used commercially on sugar beets in certain territories in which The Great Western Sugar Company operates for a period of three years. It has been used to control small seeded annual grass weeds and annual broadleaf weeds. In some areas in which the Northern Ohio Sugar Company operates, endothal has been used commercially for two years.

A deterring factor to the more general use of this herbicide has been the lack of satisfactory performance on sandy soils and under conditions of limited rainfall where furrow irrigation is used for germination. The performance of endothal for weed control in sugar beets has been good when applied to clay and loam soils under conditions of moderately cool soil temperatures and moderate to heavy rainfall during the early growing season of the crop. In the case of endothal use on sandy soils, weed control has been good but beet growth has been retarded and the stand of beets reduced. Endothal use on clay soils which have been furrow irrigated to start the crop has given little control of weeds and shown no effect on the beets. Furrow irrigation combined with rainfall or snowfall has resulted in good weed control. This suggests there may be a placement problem when furrow irrigation is used. Or perhaps the sealing effect produced by the rain is beneficial. Rain tends to compact the soil, and weed germination thus may be confined to a limited layer near the soil surface which could have been thoroughly permeated with endothal.

In much of the North Platte Valley in Western Nebraska endothal has lowered yields of beets even at the relatively low rate of three lb/A applied as a broadcast spray ahead of planting. Consequently, The Great Western Sugar Company has not, to date, generally recommended use of endothal in this area and has continued research studies that have shown encouraging results.

As early as 1957 it was believed that tolerance and non-tolerance to endothal existed within sugar beet varieties. The progeny of beets that had sustained growth in sand treated with a high rate of endothal showed marked improvement in tolerance to endothal. Later generations of this selection have continued to carry tolerance to endothal.

Another approach, conducted in cooperation with the Pennsalt Chemicals Corporation, has been to improve the usefulness of endothal by preparation and evaluation of several endothal derivatives. In Table 1 is a report of field results from Scottsbluff, Nebraska on the comparison of variety with endothal and two new derivatives of endothal. The test plots were each 6 rows through the field. The beets were planted April 26. Weeds were counted May 27 and included annual grass and broadleaf weeds. Harvest results were obtained early in November.

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Table 1. Weed kill and harvest results from endothal formulation and sugar beet variety comparison at Scottsbluff, Nebraska—1960

Treatments[a]	Weed kill pct	Beet yield tons/A	Sugar in beet pct	Yield of sugar lb/A
Tolerant variety—no endothal	0	20.0	18.2	7280
Tolerant variety—1½ lb/A TD66	36	19.2	18.6	7130
Tolerant variety—3 lb/A TD66	65	19.1	18.8	7180
Tolerant variety—3 lb/A TD62	41	15.6	18.0	5610
Tolerant variety— 3 lb/A Sodium endothal	48	—	—	—[b]
Common variety—1½ lb/A TD66	4	17.2	18.5	6360
Common variety—3 lb/A TD66	58	15.6	18.0	5600
Common variety—3 lb/A TD62	31	17.6	17.8	6270
Common variety— 3 lb/A Sodium endothal	56	16.6	17.7	5890
Common variety—no endothal	0	18.8	18.6	6980

[a] The rates of the coded endothal formulations are based on equivalents of endothal disodium salt. All materials were sprayed broadcast and plots harrowed for incorporation of chemical into the soil just prior to planting.

[b] Due to lack of uniformity in planting, harvest data were not taken.

While the harvest results are lacking in Table 1 on the tolerant variety treated wth 3 lb/A of sodium endothal, it was observed in areas of the plot uniformly planted that the stand of beets was good and the growth more vigorous than the common variety treated at 3 lb/A of sodium endothal.

To test further the performance of endothal derivatives in comparison with the common disodium salt of endothal, a second test was made at Brighton, Colorado. In this test only the common variety of beets was planted. Application of the herbicide and planting was performed simultaneously. One set of treatments and planting was completed on April 27 and a second set of treatments and planting was completed on an adjacent area May 4. The soil was a clay loam and represents much of the area in the South Platte Valley. In this valley, endothal has given good weed control without affecting sugar beet yields. Since the herbicides applied showed negligible injury to the sugar beets, individual plot harvest was not undertaken. The counts to evaluate pre-thinning beet stand and kill of annual broadleaf and grass weeds for each herbicide are given in Table 2.

Table 2. Performance of regular endothal formulation in comparison with some new derivatives and formulations at Brighton, Colorado—1960.

Treatments[1]	Pre-thinning beet stand pct of check[2]	Kill of broad leaf weeds pct of check[2]	Kill of grass weeds pct of check[2]
Check, no endothal	100	0	0
1 lb/A of TD62	90	39	11
1 lb/A of TD66	86	67	60
1 lb/A of TD66a	97	72	68
1 lb/A Sodium endothal	87	56	75

[1] Pounds per acre is that of active ingredient expressed as equivalents of endothal disodium salt applied to a 6-inch band on 22-inch rows. Broadcast rate would be 3⅔ times stated rate.

[2] Percentages were calculated from counts taken June 7 and are mean values of the two dates of planting.

The formulation TD62 gave poor weed kill and this can also be observed in Table 1. The formulations TD66, TD66a and the reguar sodium endothal formulation gave appreciable weed kill.

Developing and growing a variety of beets tolerant to endothal will permit higher rates of the selective herbicide to be used and permit endothal usage over a wider range of soil types. Even with the present beet varieties and the standard formulation containing disodium salt of endothal, near 50 percent of the sugar beet acreage grown for the Northern Ohio Sugar Company in 1960 was sprayed with endothal.

On much of the acreage of beets in Colorado a planned program of using chemical and mechanical weed control together with good equipment for planting monogerm seed has reduced the hand labor requirements. The two items which this paper has dealt, that of introduction of endothal tolerant seed and improvement in endothal formulation, are expected to give real impetus to the elimination of the now required transient labor.

[1] The Great Western Sugar Company, Longmont, Colorado.

VARIETAL RESPONSES OF OATS TO ATRAZINE

D. W. Smith and K. P. Buchholtz[1]

In two greenhouse and three field trials, tests were made on the relative sensitivity of 20 varieties of oats to applications of atrazine at planting time. Rates of ¼ to 2 lb/A were used.

Greenhouse trials included a preliminary screening experiment with 15 varieties, and a follow-up with what appeared to be the two which were the most tolerant and the two which were the most susceptible in the first experiment. In both instances fresh weight of tops was taken 21 days after planting at the time when the most susceptible variety at the highest rate was completely dead. Minhafer and Beedee appeared to have the greatest tolerance, although Beedee did not show tolerance in later field trials. Fayette and Branch showed a markedly low tolerance in both experiments.

Field studies consisted of a repeat of the four-variety trial and two larger experiments which included 20 varieties. These were the 15 initially used in the first greenhouse work and five others which were either experimental or newly released.

The four-variety trial was allowed to grow until the control plots were in the boot stage, and dry weights of tops were taken. On the 20-variety field experiment, the measure of damage was taken as per cent of plants injured after 16 days. In the other, both this measure and dry weight of tops were obtain 30 days after planting.

The tolerance of Minhafer, X643-41, and Newton was highly significantly greater than all other varieties. Fayette, Portage, and Branch were among the most susceptible.

[1] Department of Agronomy, University of Wisconsin, Madison, Wisconsin.

CDAA AND TRICHLOROBENZYL CHLORIDE RANDOX T-PERFORMANCE AND NEW USES

L. S. Gleason, E. C. Spurrier and R. E. Althaus[1]

Randox T, a mixture of *α*-chloro-*N*,*N*-diallylacetamide (CDAA) and trichlorobenzyl chloride, has been tested at many experiment stations for several years with excellent results. Testing conducted during this period demonstrated that a combination of 3 lb of CDAA and 7.5 lb/A of TCBC would give commercially acceptable weed control in field corn. In 1960 Randox T was sold in commercial quantities in the Corn Belt.

To determine the performance of Randox T, Monsanto's Sales Department interviewed farmers who had used Randox T. The survey included 165 fields which ranged in size from 8 to 600 acres, totaling 10,000 acres.

The classifications used were excellent, good, fair and poor. The excellent rating was considered as 100% control of all annual weeds, the good classification as a

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level of weed control in which scattered weeds were present in the field or band, the fair category as a level of weed control where the stand of weeds was reduced but where cultivation would be required to achieve complete weed control and the poor rating as when unacceptable weed control was obtained. The data showed that 93% of the applications gave acceptable grass control, and 95% of the applications gave commercially acceptable broadleaf weed control. This is considered a good record for commercial use. It should be noted that some of the poor classifications resulted from poorly prepared seed beds or application on light or sandy soils, for which Randox T is not recommended.

This record was achieved in a year when weather and soil conditions were not considered normal. A record of the timing and amount of the first rainfall after application shows the average time of the first rain for all treatments in all states was 3½ days and was approximately 1 inch in amount. The range in rainfall was from 0.10 inch to 5 inches for the first rain. These conditions are considered as above normal rainfall for the Corn Belt. Also, a large percentage of the growers reported heavier than normal rainfall after application of the herbicide.

Another factor which was investigated was the range of rainfall conditions under which Randox T could be effective.

These data show that Randox T performed satisfactorily under rather droughty conditions when only .37 inches of rain fell in the first two weeks and extremely rainy conditions when 4 inches of rain fell in the first two weeks after application. This information demonstrates that Randox T will perform satisfactorily under a wide range of rainfall conditions. Further, it has been recognized in the field that Randox T performed excellently in areas receiving normal or less than normal rainfall.

Randox T has been tested four seasons as a herbicide for weed control on onions. This testing has shown the product to give good weed control in onions at Minnesota and at several other locations in the East and West. Recently, Randox T was tested at New York state as pre- and post-emergence applications on onions. This work showed that excellent weed control resulted from applications of 9 quarts of the emulsifiable formulation or 63 lb/A of the granular formulation. No reduction in onion stand or yield was noted.

Residue work is in progress to clear the use of Randox T on corn grown for silage, sweet corn and onions. It is expected that the Randox T label will be cleared for these crops in time for the 1961 season. Other crops on which Randox T has shown promise are carrots, lupine, peas, sorghum and transplanted celery.

[1] Monsanto Chemical Company, St. Louis, Missouri.

PERFORMANCE OF PRE-EMERGENCE HERBICIDES ON CORN 1960

J. L. Williams, Jr. and O. C. Lee[1]

A slightly below normal seasonal rainfall and cool temperatures during May and June existed in the reported areas. Despite this fact, the timeliness of the rainfall throughout the growing season made this an excellent corn year. Even though the weed population varied between treatments, the growing season stimulated yields to the point of masking the effect of weed competition.

On two adjacent test areas Funks 95A corn was planted May 3, in a Chalmers silt loam soil. Overall applications of atrazine 3 lb/A, simazine 3 lb/A, CDAA 4 lb/A, CDAA 3 lb/A plus trichlorobenzyl chloride 7.5 lb/A, and 2,4-D (PGBE ester) 2 lb/A were made on both areas. These rates are applicable to Indiana conditions.

These materials were applied as liquids May 24 on 4 random replicated hand-hoed plots, each 4 rows by 35 feet long, to reveal the effect of the chemicals. With the exception of CDAA all the treated plots had a significantly greater yield that the untreated plots.

Treatments	bu/A yield
Atrazine	168.1
Simazine	164.9
2,4-D	158.1
CDAA plus trichlorobenzyl chloride	154.5
CDAA	143.1
Untreated	144.3

The same five materials were applied both as liquid and granules on 3 random replicated non-cultivated plots, each 4 rows by 35 feet long. The applications were made May 24 and 26 respectively. No significant difference existed between the treated yields; however, all the treated plot yields were greater than the untreated non-cultivated check. The weeds consisted primarily of crabgrass, barnyard grass, yellow foxtail, pigweed, jimsonweed, smartweed, and lambsquarters. The populations were recorded August 29; this is a late season evaluation and discriminates against those herbicides having short soil life. In light of this only a comparison between liquids and granules is reported. The granular treatments of atrazine, simazine, and CDAA were less effective than the liquid; however, granules of CDAA plus trichlorobenzyl chloride and 2,4-D were slightly more effective than the liquid. The weed population of all the treated plots was significantly less than that of the untreated plots.

This next reported test area was arranged as a demonstration. On May 24, two days after planting, both liquid and granular applications of the five materials were made to a silt loam heavily infested with giant foxtail. The non-replicated plots, 8 rows by 100 feet long, had one cultivation to remove only the row centers on August 1. The foxtail plant count was taken November 16 from a 6 inch uncultivated band in the row. The liquid application of CDAA plus trichlorobenzyl chloride (19,800 plants/A) and CDAA (24,200 plants/A) gave excellent foxtail control followed respectively by atrazine (55,000 plants/A) and simazine (83,600 plants/A). 2,4-D (200,200 plants/A) gave very poor control and was only slightly better than the untreated check (288,200 plants/A) in November. The granules, apparently slower acting than the liquid in all treatments, were less effective in control of foxtail with exception of 2,4-D and CDAA plus trichlorobenzyl chloride. The latter two materials were slightly more effective in the granular form. This comparison is the same as stated previously for the five materials. The farmer's timely rotary hoeing plus two cultivations this year gave control equal to that of CDAA. An interesting point showing the effect of early foxtail competition was pointed out in this demonstration. The 2,4-D treated plot, with a yield similar to CDAA, failed to give effective foxtail control by the November plant count; however, observations and photographs showed a reduced or retarded foxtail population in late June. This is in contrast to atrazine granules with a low corn yield correlating with a poor foxtail control.

Crop injury over the state was observed with two of the five mentioned herbicides. 2,4-D granules applied as a pre-emergence 14 inch band over the row, used on a large scale in the state for the first time this year, gave considerable crop injury in all sections of the state. The injury was of such severity that in some instances fields were disced and replanted. Two replantings were situated so that comparative yield sampling could be performed. Of these, one replanting gave a 30.2 bu/A increase while the other failed to increase the yield. Symptoms of the injured plants consisted of failure of leaves to unroll, leaf twisting, and poor root development resulting in lodging. The most severely affected plants did not survive, thus reducing stand. The surviving plants were malformed, shorter than normal,

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and barren. The spotty irregular pattern of injury was indicative of uneven distribution of the 2,4-D granules. In one case heavy rains immediately following treatment seemingly caused granule movement from the sloping sides of the row depression into the bottom thus increasing the final rate immediately over the row. Soil sampling and assay from this field showed the highest concentration of 2,4-D in the bottom of the row depression immediately over the corn.

Slight to moderate damage was reported by farmers from CDAA plus trichlorobenzyl chloride. Weed control was inconsistent.

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RESPONSE OF SOME WOODY ORNAMENTAL PLANTS TRANSPLANTED TO SOIL IMMEDIATELY AFTER APPLICATIONS OF SIMAZINE

L. C. Chadwick[1]

To determine the tolerance and growth response of some woody ornamental plants to applications of simazine, six species of evergreen and deciduous plants were transplanted to soil in gallon containers immediately after applications of simazine at rates of 2½ and 5 pounds per acre. Rooted cuttings established in pots or one-year liners of *Abelia grandiflora*, *Forsythia intermedia* 'Spectabilis', *Ilex crenata* 'Convexa', *Juniperus chinensis* 'Hetzi', *Pyracantha coccinea* 'Lalandi' and *Taxus media* 'Hicksi', were planted in a soil mixture consisting of equal parts by volume of sand, peat and silt loam on May 4th, 1960. The soil components were thoroughly mixed, spread in layers 6" deep, and treated with herbicides at the specified rates. The soil medium was thoroughly mixed again, placed in one gallon cans and the plants set in the medium immediately. There were five plants of each kind in each plot and the plots were replicated three times.

Toxicity symptoms first appeared on *Forsythia intermedia* 'Spectabilis', *Ilex crenata* 'Convexa' and *Pyracantha coccinea* 'Lalandi' in 10 to 14 days. The first visual symptoms were a decrease in growth rate, yellowing and mottling of young leaves at the top of the plant and, as the injury progressed, it was manifested by a burning of the leaf margin and some defoliation.

Forsythia intermedia 'Spectabilis'—On plants in soils treated at the 5 lb/A rate, the terminal foliage present at the time of planting became chlorotic in about 10 days. Older leaves showed some chlorosis but not as extensive as the younger leaves. Plants continued to grow at nearly normal rate and by fall plants were approximately the same size as the control plants and chlorosis was hardly discernible. There was only slight injury manifested by chlorotic foliage on the plants in the soil treated at the 2½ lb/A rate and recovery was fairly rapid.

Ilex crenata 'Convexa' — There was little noticeable injury at the 2½ lb/A rate and plants appeared nearly normal by fall with only a slight decrease in growth. The terminal foliage present at the time the plants were planted in the containers containing soil treated with simazine at the 5 lb/A rate became very chlorotic. Chlorosis or mottling was noticeable on many of the older leaves. New growth was restricted but the new leaves produced appeared nearly normal.

Pyracatha coccinea 'Lalandi' — This plant showed more damage from simazine than any of the other plants in the experiment. Considerable chlorosis was apparent two weeks after treatment on the foliage of plants in the ½ lb/A plot, but new growth occurred at nearly normal rate in late summer and fall. There was little evidence of chlorosis and total growth of these plants was equal to the control plants at the end of the season. Foliage on the plants in the 5 lb/A plot was very chlorotic and many leaves showed margin burn, even complete browning and death. Growth during the year was somewhat restricted although near the end of the season it was satisfactory. Plants made approximately 15 inches of growth during the year compared to 18 inches for the control plants.

Abelia grandiflora, *Juniperus chinensis* 'Hetzi' and *Taxus cuspidata* 'Hicksi' showed no apparent injury at either rate of application when judged by appearance of the foliage or total growth during the season.

It would appear from these experiments that nurserymen should expect considerable variation in the tolerance of woody ornamental plants to applications of simazine. The treatments reported here were more severe than would be practiced under general nursery conditions. Previous experiments have indicated that a 2 lb/A rate of simazine applied in the fall will give satisfactory weed control. There would appear to be little need of increasing the rate of 5 lb/A for the more common broadleaf weeds and annual grasses. Greater toxic effect from simazine could be expected from planting plants in soils immediately following a thorough mixing of the simazine with the soil, than where plants are lined out and then the herbicide applied to the surface as is the more common practice under nursery conditions.

[1] Department of Horticulture, Ohio Agricultural Experiment Station.

GERMINATION AND GROWTH OF OATS SEEDED IN SIMAZINE TREATED SOIL

L. C. Chadwick[1]

Oats are frequently used as a fall cover crop in small evergreen nursery stock. There has been some concern about the germination and growth of oats seeded in soils previously treated with simazine. To determine the delay in seeding necessary to assure satisfactory germination and growth, a silt loam soil was placed in gallon containers and surface treated with simazine at rates of 1½ and 3 lb/A. Oats were seeded at 2 week intervals following treatment up to 12 weeks. The containers were placed on a bench in a 65°F greenhouse and watering was practiced at needed. Treatments consisted of 1-can lots replicated 5 times.

Two methods of sowing the oats were practiced, (1) holes punched in the soil, the seed dropped in the hole and the hole closed, and (2) the soil surface was stirred, furrowed, the seeds dropped in the furrow and finally the soil stirred again to lightly cover the seed. Fifty oat seeds were sown per can, the first sowing made on February 27th, 1960, two weeks after surface applications of the simazine. Thereafter seeding occurred at two week intervals up to May 7, 1960.

Germination of the oats occurred in 5 to 6 days with approximately 85% germination of both check and treated plots. Growth of the oat seedings appeared normal in all treatments for a period of approximately two weeks, after which dying occurred at variable rates and degrees. As would be expected, injury to the oat seedlings was most severe in the 3 lb/A treated plots and in plots where the seeding was made soon after treatment. Less injury occurred where the oat seeds were placed in holes than in the stirred medium.

Data presented in Table 1 indicate that nurserymen could expect to obtain satisfactory germination and growth of seedlings sufficient to give adequate fall cover when oats are seeded, in the usual manner, in a soil

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similar to the one used in this experiment, after 8 to 10 weeks following applications of simazine at 1½ lb/A rate and after 10 to 12 weeks at the 3 lb/A rate.

Table 1—Percentage of oat seedlings, compared to controls, present (6/30/60) following seedings at 2-week intervals in stirred simazine-treated soil.

Intervals of seeding after simazine treatment on 2/27/60	Rate of application of simazine	
	1½ lb/A	3 lb/A
	%	%
Control	85.0	85.0
2 weeks	12.5	2.5
4 weeks	6.0	0.0
6 weeks	16.0	2.5
8 weeks	52.5	10.0
10 weeks	75.0	45.0
12 weeks	95.0	62.5

[1] Department of Horticulture, Ohio Agricultural Experiment Station.

OBSERVATIONS OF CROP TOLERANCE AND WEED CONTROL ON ORNAMENTALS WITH DIMETHYL 2,3,5,6-TETRACHLOROTEREPHTHALATE (DACTHAL)

Albert DiDario[1]

The purpose of these studies was to evaluate Dacthal®, (dimethyl ester of 2,3,5,6-tetrachloroterephthalic acid), applied as aqueous sprays and granular formulations on 32 herbaceous perennials and woody ornamentals to determine species tolerance and weed control.

These studies were conducted at four nursery locations near Painesville, Ohio on plant liners, transplanted to mineral soils including sandy, loamy sand and loam types, plowed and cultivated by the nurserymen during April and May 1960. Plots, where required, were also hand-cultivated the day before treatments.

Replicated rectangular plots varied in size and design, depending upon availability of specific species, plant characteristics and number of replications. Plot sizes ranged from 9 to 27 square feet and replications numbered from two to fourteen.

Dacthal W-50, the wettable powder formulation, was applied in water equivalent to 150 gallons per acre with a Kidde pressure sprayer. Dacthal G-1.5F (1.5% fast water-disintegrating), Dacthal G-1.5S (1.5% slow water-disintegrating) and Dacthal G-5F (5% fast water disintegrating) granular formulations were applied with custom made "salt shakers". All formulations were applied at 5, 10 and 15 lb/A.

Evaluations of weed control and crop response in all tests were recorded on June 26th and August 5, 1960. Only the latter data is being reported. Results from the first evaluation were slightly better than the data presented here, but followed the same general pattern.

The degree of weed control was evaluated by making weed counts, except that in *Rhododendron molle* plots, because of the large number of weeds in the checks, purslane was counted in a small-plot sector.

Injury ratings were based on area of foliage and stem injury and rated on a scale of 0 = no injury to 11 = entire plant dead. Chlorosis was similarly recorded. The following table lists the ornamental species involved in the tests and whether plant response was unfavorable.

Table 1. Ornamentals treated with Dacthal

Herbaceous ornamentals	Woody ornamentals
Achillea filipendulina	*Erica carnea*
Ajuga genevensis[1]	*Forsythia* sp.
Aster sp.	*Hedera Helix*
Chrysanthemum sp.	*Iberis sempervirens*
Chrysanthemum maximum	*Ilex Aquifolium*
Dianthus sp.[1]	*Ilex convexa*
Dicentra spectabilis	*Ligustrum ovalifolium*
Doronicum caucasicum[1]	*Magnolia Soulangeana*
Heuchera sanguinea	*Pachistima Canbyi*
Iris sanguinea alba[2]	*Parthenocissus* sp.
Lavandula officinalis[1]	*Pieris japonica*
Phlox subulata[1]	*Rhododendron molle*
Scabiosa caucasica	*Rosa multiflora*
Teucrium Chamaedrys[1]	*Taxus cuspidata*
Veronica longifolia[1]	
Vinca Minor	
Viola sp.[1]	

[1] Species exhibited injury rated 1 to 4 on June 29th, but recovered completely prior to evaluation on August 5th.

[2] Species exhibited severe injury on both dates.

In the first evaluation, *Ajuga, Dianthus, Doronicum, Lavandula, Phlox, Teucrium, Veronica,* and *Viola* treated with Dacthal at 10 and 15 lb/A, exhibited injurious effects. These symptoms were reflected by minor degrees of stunting or chlorosis. Before the second evaluation, all these species recovered completely. Siberian iris showed serious injury at all rates during the entire season. No injury was exhibited by the woody ornamentals. The data obtained indicate that, under the conditions of the tests, and at the rates of treatment herbaceous and woody liner nursery stock is generally tolerant of Dacthal formulations.

The weed spectrum in the test plots consisted primarily of crabgrass, purslane and lambsquarters, which were recorded separately, and of common chickweed, ragweed, smartweed, pigweed, horsenettle and red sorrel, which were lumped together in the miscellaneous column of the table which follows.

The weed control data, shown in Table 2, more accurately reflect the biological activity demonstrated by Dacthal than other data where no significant differences between various formulations could be noted and indicate that crabgrass, purslane, lambsquarters, and common chickweed, were effectively controlled by the formulations applied in the tests. Dacthal G-5F was less effective generally, because distribution and coverage

Table 2. Weed control exhibited by Dacthal formulations applied June 8, 1960 on *Rhododendron molle.*

Dacthal form.	Rate lb/A active	Per cent weed control			
		Crabgrass 8/3	Purslane 8/3	Lambsqtrs. 8/3	Misc. 8/3
W-50	5	88	94	87	31
	10	96	96	90	34
	15	98	96	92	47
G-1.5F	5	94	96	80	22
	10	92	97	87	29
	15	90	99	91	38
G-1.5S	5	90	98	72	20
	10	94	100	84	36
	15	96	100	88	40
G-5F	5	68	82	74	23
	10	76	90	81	37
	15	82	94	88	42
Weeds per sq. ft. of check plots		8	299	6	4

were not as good as that obtained with the other formulations. It is evident that economic control of many broadleaved weeds, such as ragweed, smartweed, horsenettle, and pigweed, was not obtained. This confirms previous findings as to their susceptibility to Dacthal. Therefore, it is suggested that Dacthal can be applied safely in a number of ornamental plantings about the home and in commercial nurseries and can be effective in controlling weeds when the complex consists largely of annual grasses, and the following broadleaved weeds; purslane, lambsquarters and common chickweed.

[1] Diamond Alkali Company, Research Center, Painesville, Ohio.

PERFORMANCE OF SELECTED PRE-EMERGENCE HERBICIDES ON NEWLY ESTABLISHED STRAWBERRY PLANTS [1]

R. C. Long[2] and R. W. Campbell[3]

Weed control and crop tolerance of surface applied pre-emergence herbicides to newly established strawberry plants in a sandy loam soil were studied during the 1960 season.

Performance of various rates and formulations of the following herbicides were compared: trietazine; simazine; 2,4-DEP (Falone); dimethyl 2,3,5,6-tetrachloroterephthalate (Dacthal); *O*-(2,4-dichlorophenyl) *O*-methyl isopropylphosphoramidothioate, (Zytron); EPTC; diphenylacetonitrile, L-13489; *N,N*-di(*n*-propyl)-2,6-dinitroaniline, L-31864; *N,N*-dimethyl-2-2-diphenylacetamide, L-34314; sesone; dalapon; and granular formulations of the iso-octyl(2-ethylhexyl) ester of 2,4-D and the propylene glycol butyl ether (PGBE) ester of 2,4-D. Pocahontas, Surecrop and Armore varieties of strawberry were used with the same representative treatments of most of the herbicides applied to each variety to allow comparisons of tolerance differences due to varietal characteristics.

Applications of trietazine, simazine, L-34314, simazine-EPTC mixture and neburon gave 95-100 percent weed control, and treatments of Dacthal, Zytron, EPTC, and L-31864 gave 85 to 95 percent weed control. Trietazine, simazine and L-34314 demonstrated effective weed control for the full season, while Zytron, Falone, sesone and the 2,4-D granular formulations did not give effective weed control after 30 days, suggesting need for repeat applications.

Simazine and trietazine treatments resulted in crop injury that varied from none to severe on an individual plant basis except that at higher rates of application injury was more uniform. Injury from these herbicides consisted of foliar chlorosis and necrosis that intensified when the plantings were subject to moisture stress. Application of these herbicides resulted in severe injury to plots of Armore variety and death of plants in some cases, while Surecrop variety showed little injury except reduction of runner plants. Pocahontas variety was intermediate.

Reaction to the granular formulations of 2,4-D varied greatly. Applications of the PGBE ester at 4 lb/A resulted in severe necrosis and, in some cases, death of the plants; while applications of iso-octyl(2-ethylhexyl) ester resulted in epinasty only and the plants resumed normal growth within a few weeks.

[1] Contribution No. 308, Department of Horticulture, Kansas Agricultural Experiment Station, Manhattan.

[2] Graduate student, Department of Horticulture, Kansas State University, Manhattan.

[3] Associate Pomologist, Department of Horticulture, Kansas Agricultural Experiment Station, Manhattan.

VARIETAL RESPONSE OF SWEET CORN TO SIMAZINE

Don Chaplin and E. K. Alban

During the past five years, simazine has been used as a pre-emergence treatment with many varieties of sweet corn and on a rather wide range of soil types. When this herbicide has been used at 1.5 lb/A to 3.0 lb/A, active ingredient, there has been a minimum evidence of damage to sweet corn.

However, based on previous experience with other herbicides, it seemed desirable to determine if there might be differences in tolerance of varieties of sweet corn to (1) the possible accidental applications of simazine at rates higher than normally considered necessary for weed control; and (2) the possible accumulation of this herbicide in soils, where annual applications were made over a period of years in a continuous sweet corn production schedule.

Certain preliminary laboratory and greenhouse studies were conducted, and based on results of these studies, field studies were initiated. Essentially, ninety varieties of sweet corn were subjected to pre-emergence applications of 5.0 and 10.0 lb/A of simazine and growth characteristics of these plants were observed and recorded over an eight week period.

In this study, there was no evidence of delay in germination or reduction in stand with any of the sweet corn varieties included in the study regardless of the amount of simazine used. Seventeen out of the ninety varieties included in this study did reveal statistically significant dwarfing of the plants as compared with the untreated check when ten pounds of simazine was used pre-emergence. Seneca, Brave, Aurora, Earlichief, Golden Zenith, Sugar Cross, Aristogold Bantam Evergreen, Valley Gold, Yukon, Tenderfreezer, Evertender C, Golden Security, Honey Gold, Sierra Gold, Hybrid 102, Hybrid 107, NK 81 and NK 199 were varieties of sweet corn which showed significant dwarfing following the use of 10 lb/A simazine.

Ten of the ninety varieties were also included in replicated plots in an attempt to determine the effect of 5.0 and 10.0 lb/A of this herbicide on the general growth characteristics, maturity, ear number and weight, total yield, and quality of the sweet corn harvested.

Sucker growth in height and number was suppressed to varying degrees in all of the ten varieties studied at 10.0 lb/A. Iochief and Deep Gold were significantly checked in sucker development at even 5.0 lb/A. There was a definite delay in tassel development with all of the ten varieties tested at 10.0 lb/A as compared with the check or control plants. Deep Gold and Golden Cross Bantam varieties were significantly delayed in tassel development at 5.0 lb/A of simazine used pre-emergence. Evertender C, Iochief, Golden Sensation, and Deep Gold revealed a slight delay of maturity, about two to four days, where the 10.0 lb/A rate of simazine had been used. Iochief and Deep Gold revealed some indication of delayed maturity at even the 5.0 lb/A rate of simazine.

The variety Deep Gold was particularly sensitive to simazine as evidenced by a statistically significant reduction in total weight and number of ears harvested from the 5.0 and 10.0 lb/A plots of simazine. Golden Security and Evertender C varieties also had significant reductions in yield, total marketable number and weight of ears, following 10.0 lb/A of simazine pre-emergence.

The average ear weight was reduced at both 5.0 and 10.0 lb/A of simazine as compared with the check plots with the varieties Tendermost Regular, Golden Cross Bantam, Deep Gold, and Victory Golden. Reduction of ear weight, at 10.0 lb/A of simazine was also noted with the varieties Asgrow Golden 22, Gold Cup, Golden Sensation.

These studies would indicate that the accidental ap-

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plication of 5.0 to 10.0 lb/A rates of simazine or an accumulation of this compound in sweet corn soils might result in delayed maturity, lower yields, or other deleterious effects on some varieties of sweet corn.

GRANULAR AND SPRAY APPLICATIONS OF HERBICIDES TO GREEN BEANS [1]

Delbert D. Hemphill[2]

Since 1949 studies have been conducted on the use of herbicides for the control of annual weeds in green beans. Most of the more promising pre-emergence herbicides have been used in these studies. Many of these herbicides although dependable from a weed control standpoint, have consistently caused serious crop injury while others have appeared promising in some seasons but have caused reductions in stand and yield in other seasons.

Weather conditions between time of planting and time of germination were an important factor in the performance of the herbicide. Heavy rains which leached the herbicide down to the level of the germinating seed resulted in considerable injury with many herbicides. With such erratic performance it was several years before any herbicides were available that could be suggested to the grower.

With granular formulations of several herbicides available it was decided to compare granular formulations applied at emergence with liquid formulations applied pre-emergence. It was thought that possibly granulars applied at emergence would reduce the incidence of crop injury. Experience with granular formulations of several herbicides had indicated less effectiveness in weed control so all rates were increased 5 percent over liquid rates.

Table 1 gives results of the 1960 studies using both liquid and granular formulations where available. Weed infestation was heavy. Yield differences, if any, between liquid and granular formulations appeared to be related to effectiveness in weed control.

Table 1. Weed control in snap beans, Top Crop var., 1960.

Treatment	Weed counts		Yield in pounds/plots
	BL	Grasses	
Control	36	282*	15.3
CDEC (G) 7½ lb/A	29	92	19.9
CDEC (L) 6 lb/A	13	46	21.1
EPTC (G) 7½ lb/A	27	83	20.2
EPTC (L) 6 lb/A	20	64	19.5
CDAA (G) 5 lb/A	10	26	22.8
Amiben (G) 5 lb/A	60	208	19.4
Amiben (L) 4 lb/A	40	100	21.4
DNBP (G) 7½ lb/A	26	22	26.4
N-5996 (G) 4 lb/A			less than 50% stand
N-5996 (L) 3 lb/A			less than 50% stand

* Heavy infestation of fall panicum.

Table 2. Weed control in green beans, Top Crop var.

Treatment	Yield in pounds/plot		
	1958	1959	1960
Control*	17.9	19.3	15.3
CIPC (G) 10 lb/A	21.1	19.5	—
CDEC (L) 6 lb/A	21.1	22.1	21.1
CDEC (G) 7½ lb/A	24.2	20.5	19.9
EPTC (L) 6 lb/A	24.3	20.4	19.5
EPTC (G) 7½ lb/A	24.3	21.8	20.2
CDAA (L) 5 lb/A	18.6	19.5	18.6
CDAA (G) 5 lb/A	19.1	20.8	22.8
Amiben (L) 4 lb/A	—	20.6	21.4
Amiben (G) 5 lb/A	—	20.5	19.4

* No hand weeding. Weed infestation without row heavy in 1958 and 1960.

Yield data for three year's experiments are given in Table 2. Amiben, CDEC, and EPTC have been the most satisfactory herbicides for use in this crop; however, granular formulations applied at emergence did not appear to have merit over liquid formulations applied pre-emergence. Only in the case of CDAA, which usually causes initial stunting when applied as a liquid, does a granular formulation appear to have merit.

The results with granular DNBP were especially promising in 1960 and should be tested further. N-5996 (2,6-dichlorobenzonitrile) appears to be too toxic for use in green beans.

[1] Contribution from the Missouri Agricultural. Experiment Station, Journal Series No. 2246. Approved by the Director.
[2] Missouri Agricultural Experiment Station, Columbia, Missouri.

NEW HERBICIDES FOR WEED CONTROL IN CARROTS

H. J. Hopen and S. K. Ries[1]

The control of weeds in carrots with Stoddard Solvent has been a standard practice. However, it has been an increasingly expensive practice. In addition, Stoddard Solvent has been erratic under certain weather conditions and does not control ragweed. Efforts from 1957 through 1960 have been concentrated on finding a better herbicide for carrots.

Fourteen individual experiments were carried out on muck and mineral soils near East Lansing, Michigan. In three of these tests, the herbicides were applied after weed emergence, and in the remainder the materials were applied shortly after planting the carrots.

The following herbicides were evaluated: CIPC, CDEC, EPTC, amiben, ipazine, simazine, trietazine, propazine, neburon, *N*-(3,4-dichlorophenyl)-2-methylpentanamide (Karsil), *N*-(3-chloro-4-methylphenyl)-2-methylpentanamide (Solan), *N*-(3,4-chlorophenyl)-methacrylamide (Dicryl), *O*-2,4-dichlorophenyl *O*-methyl isopropylphosphoramidothioate (Zytron), dimethyl 2,3,5,6-tetrachloroterephthalate (Dacthal), 2-*N*-isopropylamino-1,4-naphthoquinone, (Naugatuck B-562), and 2-*N*-propylamino-1,4- naphthoquinone, (Naugatuck B-621).

All of these herbicides, except amiben, Dicryl, Karsil, CIPC, Zytron, Solan, and ipazine, either caused injury at rates which controlled weeds or did not give good weed control.

Pre-emergence treatments with the herbicides evaluated resulted in better weed control than post-emergence treatments. A good pre-emergence chemical will probably be more practical for growers than a good post-emergence chemical.

The best pre-emergence treatments for mineral soil, were 2 to 4 lb/A per acre of amiben, ½ to 1 lb/A of ipazine, 5 lb/A of Zytron, and Karsil at 4 lb/A. The best pre-emergence treatments for muck soil were 1 lb/A ipazine, 4 lb/A of amiben or Karsil, and 10 lb/A of Zytron.

[1] Departments of Horticulture and Botany and Plant Pathology, Michigan State University, East Lansing, Michigan.

THE EVALUATION OF SEVERAL HERBICIDES APPLIED TO TOMATOES AT DIFFERENT TIMES AND LOCATIONS

H. J. Hopen and S. K. Ries[1]

Chemical weed control in commercial tomato plantings has not been practiced to date in most areas. Most herbicides which have given good weed control have injured transplanted tomatoes. Due to the predicted mechanization of the processing tomato crop, there will be an increased need for a suitable herbicide, because acreages will probably increase to obtain the same tonnage we now produce.

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During the 1959 and 1960 growing seasons, seven separate experiments were carried out on sandy loam at two Michigan locations in an attempt to find a suitable herbicide and rate of application which did not cause injury or reduce subsequent yield. Nine herbicides at varying rates of application were evaluated.

Granular materials were applied by shaking the material through a perforated tin can after an experimental small plot distributor proved inaccurate. Liquid applications were applied with a small plot sprayer utilizing carbon dioxide as a source of pressure. Herbicidal solutions were applied at the rate of 27 gpa with a pressure of 25 psi. No attempt was made to direct the spray.

Table 1. Data from six experiments with transplanted tomatoes.

Herbicide	Rate lb/A	Form.	Ratings		
			Weed control[1]	Injury[2]	Yield (T/A)
None	-	—	4.3(5)[3]	1.4(5)[3]	21.0(1)[3]
Solan	2	E	6.4(3)	2.2(3)	20.3(1)
Solan	4	E	7.1(4)	2.1(4)	23.1(1)
Solan	8	E	8.5(1)	2.3(1)	
Simazine	2	G	7.0(4)	2.3(4)	18.4(1)
Simazine	1	WP	6.8(3)	2.1(3)	15.7(1)
Simazine	2	WP	9.0(1)	5.5(1)*	
CDAA	4	G	7.1(3)	1.7(3)	20.0(1)
CDAA	8	G	8.3(1)	4.8(1)*	
EPTC	3	G	4.5(1)	1.0(1)	
EPTC	3	E	5.5(1)	1.0(1)	
EPTC	6	E	8.0(1)	6.8(1)*	
EPTC	6	G	8.5(1)	2.3(1)	
Amiben	2	E	7.1(3)	3.9(3)*	17.5(1)
Amiben	4	E	7.4(4)	3.5(4)*	13.5(1)
Amiben	2	G	7.3(4)	2.3(4)	24.7(1)
Amiben	4	G	8.0(5)	2.8(5)	21.1(1)

[1] Weed control rating scale; 1.0 = no control, 6.0 = commercial control, 9.0 = weed eradication.
[2] Injury rating scale; 1.0 = no injury, 9.0 = killing of plant.
[3] ( ) = Number of replicated tests.
* Caused significant injury at one or more times of application.

The herbicides which proved unsatisfactory for both direct-seeded and transplanted tomatoes, (Table 1) because they caused injury or did not give adequate weed control, were dimethyl 2,3,5,6-tetrachloroterephthalate (Dacthal), CDEC, *O*-2,4- dichlorophenyl *O*-methyl isopropylphosphoramidothioate (Zytron), EPTC, neburon and simazine. Herbicides which showed promise for future use were *N*-(3-chloro-4-methylphenyl)-2-methylpentanamide (Solan), granular CDAA, and granular amiben. Solan was tested in 1960 only. Tomatoes tolerated Solan over a wide range of application rates (2 to 8 lb/A). Granular CDAA gave good weed control and no injury at 4 lb/A but caused injury at 8 lb/A. Emulsifiable amiben at 2 and 4 lb/A gave definite injury and reduced the yield. Granular amiben at 2 and 4 lb/A gave commercial weed control without causing plant injury or reducing yield.

More adequate weed control was obtained with the addition of ½ acre inch of water at the time of herbicide application. EPTC (emulsifiable) at 6 lb/A gave very definite injury after the addition of ½ acre inch of water. Weed control with amiben was better when it was applied early in the growing season.

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EFFECTS OF CULTURAL METHODS ON YIELDS OF GLAMOUR TOMATOES[1]

J. K. Greig[2]

Market and home gardeners grow tomatoes in Kansas. Both have used hand labor to control weeds after the plants were too large for mechanical cultivation, and weed growth then is a continual problem. Experimental work was established in 1959 to reduce weeds without decreasing tomato yields.

The 1959 experiment included six methods of culture, Table 1. Their effects were measured by yield and degree of weed control. Well grown transplants were set May 14 in a randomized block design. Three row plots of 18 plants each constituted a replication. The soil was a Sarpy fine sandy loam. Plants were set 2 feet apart in 6-foot rows. All plants were cultivated once before the cultural treatments started June 10. Plastic with holes for plants was placed over each plant and anchored with soil. Mulching materials were applied under plants and on the sides of rows. Covering was 3 feet wide to be comparable with the 3-foot plastic. Space between treatments was cultivated with a rototiller.

Table 1. Cultural methods on Glamour tomatoes, 1959

Treatment	Av wt mktbl fruit	Total yield	Mktbl yield bu/A	
	lb	bu/A	Total	Early
Black plastic 3′	.31	1569	775	143
Wheat straw 3″	.32	1404	665	90
Shingletoe 3″	.30	1280	587	87
Peat moss 2″	.30	1263	594	80
Vermiculite 2″	.31	1173	540	80
Clean cultivation	.30	1135	530	90
LSD 5 percent		241	140	n.s.

Yields (tomatoes harvested in the pink stage of maturity) are shown in Table 1. The black plastic mulch increased total yields of marketable fruit significantly compared with the cleanly cultivated plots. In total yield both the black plastic mulch and the wheat straw mulch produced significantly higher yields than the clean cultivated plots. Plots ranked in order of weeds present were 1, vermiculite, 2, peat, 3, shingletoe, 4, straw, 5, plastic and 6, clean cultivation.

In 1960 another study was conducted on similar soil, as shown in Table 2. Transplants were set May 5. Spacing was also 6′ x 2′. The experimental design was a randomized block with 4 replications. Single-row plots consisting of 6 plants each were used as replicates. All treatments except N-(3-chloro-4-methylphenyl)-2-methylpentanamide (Solan) were applied immediately after setting the plants. Solan plots were scraped prior to the first application of Solan June 10. No additional cultivation was used except on the cleanly cultivated and the staked plots. Second and third applications of Solan were applied at approximately three-week intervals. Early harvest was July 8 to August 1, with no significant difference due to treatments. However, significant differences in total marketable yields were obtained for both black plastic treatments. the wheat straw treatment, and the staked treatment, compared with the noncultivated treatment. Total yields also were significantly more from those treatments. In addition the cleanly cultivated treatment was superior to the noncultivated treatment.

Table 2. Cultural methods on Glamour tomatoes 1960

Treatment	Av wt mktbl fruit	Total yield	Mktbl yield bu/A	
	lb	bu/A	Total	Early
Black plastic 3′	.42	1433	786	228
Clean cultivation	.41	1431	712	187
Black plastic 4′	.43	1416	784	234
Wheat straw 3″	.40	1363	763	144
Staked	.43	1296	752	176
Solan 12 lb/A (3 appl.)	.39	1274	647	190
Solan 8 lb/A (2 appl.)	.40	1193	598	178
Solan 4 lb/A (1 appl.)	.40	1186	615	170
No cultivation	.42	1076	602	177
LSD 5 per cent		216	134	n.s.

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The weeds in the noncultivated plots were: marestail, pigweeds, lambsquarters, climbing milkweed, large crabgrass, stinkgrass, yellow foxtail and ticklegrass. Plots treated with Solan at 4 lb/A contained pigweeds, barnyardgrass, foxtail, and stinkgrass. Plots given a second application of Solan at 4 lb/A had fewer pigweeds present, and the vigor of all weeds and grasses was reduced. Plots receiving a third application of Solan at 4 lb/A were fairly clean.

Either 3′ or 4′ wide black plastic mulching material or a wheat straw mulch approximately 3″ thick placed under the tomato plants dries off rapidly after rains or irrigation. The fruits in contact with these mulching materials are not so susceptible to ground rots as are fruits in noncultivated, clean cultivated, shingletoe, peat moss, vermiculite or Solan treated plots.

Increased yields of marketable fruit cannot be entirely attributed to freedom from weeds; therefore, cultural methods that eliminate weeds and discourage fruit ground rots are more desirable than present herbicides, or other mulching materials.

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[2] Assistant Professor of Olericulture.

PRE- AND POST-EMERGENCE WEED CONTROL IN FOURTEEN VEGETABLE CROPS AND SUGAR BEETS ON MINERAL SOILS

R. Alden Miller[1]

The crops listed below were seeded in 24-foot rows in three replications with a 36-inch row spacing. Each crop was planted in a block of rows. The small seeded crops were planted with a V-belt seeder and larger crops were planted with a jab-type planter. The soil was a silty clay loam. The seed bed was not ideal, since the soil had to be worked under wet conditions. Soil and temperatures were near normal.

The following herbicides were employed in the 1960 testing: amiben; 2-isopropylamino-1,4-naphthoquinone (Naugatuck B562); barban (Carbyne); CIPC; endothal; EPTC; EXD (Herbisan 5); neburon; CDAA; 2,6-dichlorobenzonitrile (Casoron), dimethyl 2,3,5,6-tetrachloroterephthalate (Dacthal), *N*-(3,4-chlorophenyl)methacrylamide (Dicryl), *N*-3,4-dichlorophenyl)-2-methylpentanamide (Karsil), *N*-(3-chloro-4-methylphenyl)-2-methylpentanamide (Solan), CDAA plus trichlorobenzyl chloride (Randox T); ethyl ethyl-*n*-butylthiolcarbamate (Stauffer R-2060); propyl ethyl-*n*-butylthiolcarbamate (Stauffer R-2061); simazine; *N*-*N*-dimethyl coco amine neutral salt of endothal (Pennsalt TD-47); tallow amine neutral salt of endothal (Pennsalt TD-62); and 2-dimethylamino-1,4-naphthoquinone (Naugatuck 9S4).

The cool season crops, i.e., peas, onions, beets, sugar beets, potatoes, carrots, and cabbage (both seeded and transplanted) were planted from April 13 to May 5. Pre-emergence herbicides were applied from April 23 to May 13 and 2.06 inches of rain fell between planting time and two weeks after pre-emergence treatments were applied.

The warm season crops, i.e., corn, snap beans, lima beans, tomatoes (both seeded and transplanted), cucumbers, muskmelons, and Acorn, Blue Hubbard and Baby Butternut squash, were seeded May 24 and treated on May 26. Rainfall two weeks after pre-emergence treatment totaled .65 inches. Although the soil was moist, no flush-type rain fell to cause optimum activation of the less soluble herbicides.

The cool season crops were treated with post-emergence herbicides on June 9 and received 2.23 inches of rain during the following two weeks. The warm season crops received post-emergence treatments on June 25 and 1.40 inches rain in the following two weeks.

Evaluation data included time required to weed 24 feet of row, weed count and weight on 2.35 square feet, which was projected to a per acre basis, and herbicide injury noted in words.

The following tables list the promising results in summary. Choices 1 and 2 appeared to be practical for grower use. Choice 3 was questionable but will be repeated in 1961 for further evaluation. Figures are lb/A active herbicide and liquid or granular form is indicated by L and G.

Table 1. Pre-emergence herbicide results

Crop	1	2	3
Beets	Endothal 5, L	Endothal 5, G	
Peas	Dacthal 4, G	Casoron 4, L	Casoron 4, G
Onions	Randox 4, L	Randox 4, G	CIPC 6, L
Sugar beets	Endothal 5, G	Endothal 5, L	TD-62, 5, L
Carrots	CIPC 8, G	CIPC 8, L	Dacthal 8, L
Cabbage (D.S.)	Randox-T 8, G	Dacthal 8, G	Dacthal 8, L
Potatoes		Casoron 4, L	Casoron 4, G
Sweetcorn	Dacthal 8, L	Randox 4, L	Dacthal 4, L
Beans, lima	Randox 4, G	Casoron 4, G	Casoron 4, L
Beans, snap	Randox 4, L	Casoron 4, G	Casoron 4, L
Tomatoes (D.S.)	Randox 4, L	Solan 4, L	Neburon 4, L
Cucurbits*	Amiben 4, L	Amiben 6, L	Amiben 6, G

* Includes cucumber, muskmelon, Blue Hubbard, Acorn, and Baby Butternut squash.

Table 2. Post-emergence herbicide results

Crop	1	2	3
Beets		Nothing promising	
Sugar beets		Nothing promising	
Carrots			*9S4 ¾, L Karsil 4, L
Cabbage (T-plant)	Randox 4, L Randox 4, G	Randox-T 8, G	Casoron 4, L
Cabbage (D.S.)	Dacthal 8, L	Randox-T 8, G	Randox 4, L
Potatoes			Casoron 4, L
Onions	*B562 ¾, L *9S4 ¾, L	*TD-47 2, L	
Snap beans			Casoron 4, L
Lima beans		Nothing promising	
Tomatoes (T-plant)	Randox 4, G	Dacthal 4, G	Casoron 4, L
Tomatoes (D.S.)	Simazin 2, L	Casoron 4, L	
Cucurbits		Nothing promising	

* Post-weed applications.

[1] University of Illinois, Drug and Horticulture Experiment Station, Box 58, Downers Grove, Illinois.

CONTROL OF WEEDS IN VEGETABLE CROPS WITH A SUBSTITUTED DIPHENYLACETAMIDE

E. F. Alder, W. L. Wright, and Q. F. Soper[1]

Extensive studies in the greenhouse and field have been conducted on a large number of substituted diphenylacetonitriles and diphenylacetamides. Special attention has been given to a new selective herbicide, *N*.*N*-dimethyl-2,2-diphenylacetamide. This compound was coded as L-34134 and now bears the tentative generic name diphenamid.

In greenhouse tests diphenamid gave good pre-emergence activity against all seedling grasses tested and against broadleaf weeds such as pigweed and smartweed at 4 lb/A. A number of important horticultural and agronomic crops were tolerant to the material. Structure-activity studies revealed that lengthening the chain of the alkyl substituents of the amide portion of diphenamid resulted in reduced activity.

The promising greenhouse results with diphenamid led to its inclusion in thirteen field tests on a total of 28 different crops. Major emphasis has been on tomatoes, other vegetable crops, and forage legumes.

Diphenamid has a rather low solubility in water (260 ppm) and in most organic solvents. It was, therefore, formulated as a wettable powder and on clay granules. Applications of the wettable powder formulation were made with a small plot sulky spray rig. Granules were applied with a lawn spreader. Slightly better

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results were generally obtained with the wettable powder formulation. All field tests were replicated and of a randomized block design.

Tomatoes—Four pre-emergence field tests were conducted on tomatoes; three with field-seeded tomatoes, one with tomato transplants. In all tests 4 to 6 lb/A of diphenamid gave satisfactory control of grass weeds with no damage to tomatoes. Broadleaf weed control was generally poorer, due chiefly to the occasional presence in the plots of jimsonweed and ragweed, two species not controlled by diphenamid. Pigweed, however, was satisfactorily controlled in all trials at 6 lb/A.

Other vegetable crops—Excellent results were obtained with diphenamid in two vegetable crop experiments. Ninety-eight percent control of seedling grasses and 89% control of broadleaf weeds (primarily pigweed) were obtained at 2 lb/A. Green peppers, lima beans, peas, turnips, radishes, and mustard were not damaged by an application of 8 lb/A. Cabbage and carrots were not severely damaged at this rate. Red beets, spinach, and cantaloupe were severely damaged at 8 lb/A.

Forage legumes—Alfalfa, red clover, crimson clover, Dutch white clover, Ladino clover, birdsfoot trefoil, and Korean lespedeza were the crop plants included in three pre-emergence field tests of diphenamid on forage legumes. Severe damage to the clovers occurred at rates as low as 2 lb/A. Alfalfa, birdsfoot trefoil, and Korean lespedeza were tolerant of 4 to 6 lb/A. Grass weed control was good at 4 lb/A. Pigweed and lambsquarters were killed at 4 to 6 lb/A. Incorporation of diphenamid into the soil did not improve activity over surface application.

Field crops—Two field crop experiments were conducted in which diphenamid was applied at 2, 4, and 8 lb/A. The field crops were alfalfa, soybeans, snapbeans, corn, sorghum, oats, sugar beets, and cotton. Of these alfalfa, soybeans, snapbeans, sorghum, and cotton were tolerant to diphenamid at rates through 8 lb/A. Good grass weed control was obtained at 4 lb/A. Broadleaf weed control was satisfactory at 4 to 8 lb/A in those plots in which pigweed and smartweed were the dominant broadleaf species.

Diphenamid has no activity against non-germinating seeds. It is highly active against susceptible germinating seedlings. Established plants of susceptible species can be severely damaged or killed by post-emergence applications at higher levels. In a number of turf experiments it was found that 20 lb/A of diphenamid granules killed turf grasses such as bluegrass, bentgrass, and Bermuda grass.

Diphenamid is absorbed through the roots of susceptible plants and shows little or no contact foliar activity. In instances where susceptible plants have not been completely killed by the compound, the root system is usually severely stunted.

Three points remaining to be clarified are: 1) to what extent does translocation of diphenamid occur. 2) how is diphenamid metabolized, and 3) what is the basis for selective action (i.e., do tolerant species fail to absorb diphenamid, or is the chemical absorbed but without effect)? Chemical and tracer studies are now under way which should elucidate these points.

[1] Eli Lilly and Co., Agricultural Research Center, Greenfield, Indiana.

WEED SUSCEPTIBILITY AND CROP TOLERANCE TO PRE-EMERGENCE APPLICATIONS OF 2.6-DICHLOROBENZONITRILE (CASORON)

E. S. Hagood[1]

Casoron (2,6-dichlorobenzonitrile) was discovered by N. V. Philips-Duphar of The Netherlands. It is a white crystalline solid which melts at 144°C, has a solubility in water of 10 parts per million at 25°C, and is partially soluble in organic solvents such as xylene, acetone and cyclohexanone. Casoron, formerly NIA 5996, has been formulated as 25% and 50% wettable powder and as a 4% granular. (Casoron in this report was applied only as a wettable powder.)

It would be well to clarify one point before discussing the pre-emergence use of Casoron. Two papers by the author, "An evaluation of 2,6-dichlorobenzonitrile as a control for wild oats and other species" and " Evaluation of 2,6-dichlorobenzonitrile as a pre-planting soil-incorporated and a pre-emergence herbicide", appearing in the 1959 Proceedings of the NCWCC, discussed the use of Casoron as a pre-planting soil-incorporated herbicide. In review this method of application has been best from a herbicidal standpoint. Residues have prevented the emergence or stunted the growth of all crops seeded during the year of its application.

Five pre-emergence tests of a randomized block design, each with four replications, were studied at Gasport, New York, during 1959 and 1960. Prior to the establishment of each test, crabgrass, barnyardgrass, brachiaria, witchgrass, yellow foxtail, common ragweed, Pennsylvania smartweed, rough pigweed, lambsquarters and mustard were broadcast and disked in to increase the weed seed content of the Dunkirk silt loam soil.

Plots, each 12 x 12 feet, were seeded to one row each of the following crops (figures are depths of planting in inches): Corn (1½-2), peas (1½-2), snap beans (1½-2), soybeans (1½-2), peanuts (1½-2), cotton (1½), wheat (1-1½), rice (1½), barley (1-1½) and sorghum (1-1½). One row each per plot of the following crops was included in 3 tests—Lima beans (1½), onions (¾) and tomatoes (¾). One row each of the following crops was included in 2 tests—cucumbers (1), potatoes (3), muskmelon (1), squash (1) and sugar beets (½-1). The following crops were included in a single test—watermelons (1), spinach (½), cabbage (½), cauliflower (½) and sunflowers (2). Three rows of sweet corn in one of five tests were planted at depths of ½, 1½ and 3 inches.

Within 2 to 4 days of planting and prior to the emergence of both crops and weeds, the experimental herbicides and the standards were applied by means of a tractor-mounted sprayer at a pressure of 35 psi and a volume of 70 gpa. Casoron (2, 3 and 4 lb/A), diuron (3 lb/A), CIPC (6 lb/A) and simazine (2 lb/A) were included in 5 tests. DNBP (Sinox PE) (6 lb/A) and CDAA (6 lb/A) were included in 3 and 1 tests, respectively.

The 5 tests were treated as early as June 10th and as late as August 18th. The test conditions ranged from early season cool temperatures to late season maximums of 99°F. Dry weather responses were corrected by means of irrigations.

Performances were determined by plant counts, vigor ratings and observations at intervals of 31 days and 10 weeks after treatment. The following table presents the average percents of control as developed in the 5 tests.

Table 1. Casoron as pre-emergence spray in the control of broadleaved weeds and grasses.

Pounds per acre	Percent control			
	31 day interval		10 week interval	
	Broadleaved weeds	Grasses	Broadleaved weeds	Grasses
2	93.7	68.1	75.3	67.4
3	93.7	77.9	84.3	74.0
4	96.9	85.4	94.7	85.7

Considering all tests Casoron controlled broadleaved weeds better than grasses and 4 lb/A were required for consistently satisfactory control of annual weeds and grasses.

Casoron was compared with five standard pre-emergence herbicides. Based upon percents of control 31 days after treatment and duration of these controls at the 10 week interval Casoron at 4 lb/A effected better controls than DNBP, CIPC or CDAA, each at 6 lb/A.

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Casoron at 4 lb/A compared favorably with diuron at 3 lb/A and simazine at 2 lb/A.

In one test sweet corn was planted at depths of ½, 1½ and 3 inches. The following table gives the data.

Table 2. Effect of Casoron pre-emergence on the stand and vigor of corn, as influenced by depth of planting.

Depth of planting (inches)	4 lb/A Casoron		Untreated	
	Stand/12 ft.	Inj. sc.*	Stand/12 ft.	Inj. sc.
½	11.8	2.8	32.8	0.3
1½	26.5	0.5	34.0	0.3
3	32.5	0	34.8	0.3

* Injury scale: 0 = none, 1-3 = slight, 4-6 = moderate, 7-9 = severe, 10 = plants killed.

Based upon stand counts, vigor and injury scale ratings the following crops were tolerant of 4 lb/A of Casoron pre-emergence:

Corn (planted 1½ and 3 inches deep)	Rice
Peanuts	Lima beans
Snap beans	Cotton
Barley	Gladioli
Wheat	Squash
	Potatoes

Peas, soybeans and sorghum possessed a questionable tolerance.

The following crops have not tolerated 4 lb/A of Casoron pre-emergence:

Cabbage	Cucumbers
Cauliflower	Onions
Cantaloup	Sugar beets
Watermelons	Tomatoes
Corn (planted ½ inch deep)	Spinach

All tolerant crops except squash were planted at depth of 1 inch or deeper. The physical separation of the crop seed from the comparatively insoluble pre-emergence layer of Casoron may be a factor in crop selectivity.

[1] Research and Development Department, Niagara Chemical Division, Food Machinery and Chemical Corporation, Middleport, New York.

A PROGRESS REPORT ON 2,6-DICHLOROBENZONITRILE WHEN APPLIED POST-EMERGENCE IN ESTABLISHED CROPS

E. S. Hagood[1]

Certain properties of 2,6-dichlorobenzonitrile (Casoron) have been listed in the preceeding report by the author in these Proceedings.

This paper reports the reactions of crops to post-emergence applications.

Sugar beets, rice, sorghum, flax, onions, corn, peas and peanuts were planted in Dunkirk silt loam soil in western New York on June 25, 1959. Twenty-one days after planting, 25% wettable powder formulation of Casoron was applied as a topical spray at 4 and 6 lb/A in 70 gpa of spray.

Counts as to survival and crop vigor were made on July 28 and 29 and on August 11. With the exception of sugar beets, the crops were tolerant of 4 and 6 lb/A of Casoron. These rates had no effects on established weeds and grasses.

On June 6, 1960 corn, peanuts, cotton, cucumbers, gladioli (cormlets) and sugar beets were seeded. On June 17th onions, watermelons, cantaloup, broccoli, cabbage, celery, lettuce, peppers, sweet potatoes, tobacco and tomatoes were transplanted. Each row of each crop was 12 feet long. Plots were 12 x 76 feet and were duplicated. Prior to treatments on July 13th the crops were cultivated and hoed. Casoron as a 50% wettable powder was applied as topical sprays at 4 and 6 lb/A in 70 gpa water. Casoron as a 4% granular was also applied at 7½ lb/A. Counts of plant stand, and notes on vigor and percent of plant kill were made on August 18 and September 16th. Yields (green weights) were taken on September 26th.

Casoron (granular) was applied (August 15th) at 3, 4, and 5 lb/A after hilling and the final cultivation of potatoes. The plots had been treated at the time of planting (June 23) with 2, 3 or 4 lb/A of Casoron pre-emergence. Counts and vigor ratings were made on July 26th, September 16th and September 27th. Yields of the two center rows of each four row plot were taken on October 19, 1960.

Established Sparkle and Catskill strawberries were treated on July 6, 1960 with granular Casoron at 2, 4 and 6 lb/A. Evaluations, such as percent of plants killed, injury scale, runner production, and rooting of runners, were made on August 8th and September 7th.

Established Merion Kentucky bluegrass, common Kentucky bluegrass, and creeping red fescue were treated in a crabgrass control study on September 8th with 3, 4 and 6 lb/A of granular Casoron. Turf injuries and the percent of kill were recorded on October 6th.

Using scale in which 0=no injury, 1-3=slight injury, 4-6=moderate injury, 7-9=severe injury and 10=plants killed, the average scores following the 4 lb/A post-emergence application of Casoron were as follows:

Crop	Injury	Crop	Injury
Cotton	1.2	Cabbage	3.0
Corn	0.0	Celery	0.3
Peanuts	0.0	Lettuce	0.7
Cucumbers	0.5	Peppers	0.7
Gladioli	0.0	Sweet potatoes	0.5
Sugar beets	0.0	Tobacco	0.2
Onions	0.7	Tomatoes	0.2
Watermelons	0.5	Potatoes	0.7
Cantaloup	1.0	Strawberries	6.1
Broccoli	0.8	Turf	6.0

Except potatoes, strawberries, and turf, the post-emergence treatments were applied at about lay-by time. Since this test was established late, the crops were younger than normal and did not reach maturity. Yields on September 26th were the green weight of the plants. Based upon 100% as the yield of the untreated check, the yields following 6 lb/A of Casoron were:

Crop	Percent	Crop	Percent
Cotton	172.2	Broccoli	53.0
Corn	146.5	Cabbage	53.5
Peanuts	143.5	Celery	89.0
Cucumbers	131.0	Lettuce	62.5
Gladioli	160.0	Peppers	197.8
Sugar beets	142.2	Sweet potatoes	111.0
Onions	159.3	Tobacco	125.5
Watermelons	108.2	Tomatoes	109.2
Cantaloup	138.0	Potatoes	128.5
		(2 appl. 4 lb/A each)	

The indications of these results are that:

1. Casoron as a wettable powder or as a granular is of promise as a pre-emergence herbicide.
2. In certain established weed-free crops Casoron as a topical spray is of promise post-emergence. These data indicate that the following crops are tolerant: cotton, corn, peanuts, cucumbers, gladioli, onions, watermelons, cantaloup, peppers, sweet potatoes, tobacco, tomatoes, potatoes and celery. Sugar beets possessed a questionable tolerance.
3. Broccoli, cabbage, lettuce, strawberries, and turf were not tolerant of the weed control rate of Casoron.
4. Considering both safety and performance, the wettable powder formulation is better than the granular.

[1] Research and Development Department, Niagara Chemical Division, Food Machinery and Chemical Corporation, Middleport, New York.

INDUSTRIAL APPLICATIONS OF 3-(*P*-CHLOROPHENYL)-1,1-DIMETHYLUREA TRICHLOROACETATE (UROX) IN GRANULAR AND LIQUID OIL CONCENTRATE FORM

H. W. Ernst[1]

Industrial applications of Urox, 3-(p-chlorophenyl)-1,1-dimethylurea trichloroacetate, over the past three years have shown its effectiveness as a long residual soil sterilant for non-selective control of broadleaf weeds, grasses and woody plants.

Urox (formerly GC-2996) Weed Killers are available for application as dry granulars of 11 and 22% active ingredient, or as an oil soluble liquid formulation containing 3 lb/gal Urox. Each formulation has certain definite advantages when used in situations for which they are designed.

Urox is an excellent soil sterilant herbicide. In most areas of the North Central region, minimum dosages of 125 lb/A (product) of 22% Urox or equivalent oil concentrate provide practical weed control for one normal 5 to 6 month growing season, but higher dosages are necessary to control deep rooted perennial plants and to obtain satisfactory soil sterilization for extended periods. Rates of application of 200 lb/A of 22% product and up exhibit outstanding residual herbicidal activity the second growing season and in many cases into the third year.

Urox may be used at any season of the year. It is recommended that the granular formulations be applied either in the spring or early enough in fall to allow for some chemical absorption by the plant prior to frost. Adequate moisture to carry the active ingredient into the root zone is insured with spring application, fall application gives control as soon as growth starts the succeeding spring. The liquid oil concentrate may be used at any time of the year but is especially recommended for use when it is desired to kill existing vegetation as rapidly as possible. Urox liquid oil concentrate gives extremely rapid burnback of surface vegetation coupled with soil residual effect equivalent to the granulars at equivalent rates of application.

Tests conducted by the Association of American Railroads[2] indicate that excellent control of most weeds growing on railroad rights-of-way was obtained for two growing seasons where not less than 125 lb/A (product) of 22% Urox were used. Repeat treatments over a two year period wherein a minimum of 160 to 175 lb/A of 22% Urox was applied (e.g. 100 lb/A 22% Urox the first year followed by 60 to 75 lb/A the second year) resulted in control upwards of 95%.

Urox granular can be applied either by hand propelled or by a ground wheel propelled cyclone seeder type spreader, by a regular fertilizer spreader, by air blast spreaders or by hand. Urox liquid oil concentrate can be applied with any hand or power operated sprayer which will handle oil solutions.

Typical sites where Urox has been used successfully are on railroad rights-of-way, around switch stands, poles, signs and fence posts, on highway rights-of-way to clear shoulders and eliminate weeds from areas inaccesible to power mowers, such as around guard rails, light standards, bridges, etc., and for application to soil during construction or repairs prior to laying gravel or black top to prevent weeds from emerging through the finished road surface, industrial areas such as tank farms, parking lots, storage yards, power substations, and power and pipeline rights-of-way.

[1] Technical Specialist, Northern District, Agricultural Chemical Development, General Chemical Division, Allied Chemical Corporation, Minneapolis, Minnesota.

[2] AREA Bulletin 506, February 1960, Association of American Railroads.

BRUSH CONTROL WITH URAB

R. L. Pierpont[1]

Several years tests with Urab[2], 3-phenyl-1, 1-dimethylurea trichloroacetate, show that it is effective in the control of grass and broadleaf weeds where temporary soil sterilization is desired; it shows promise as a selective herbicide for use in certain crops, but it is most effective in the control of woody plants and brush.

Urab is formulated as a dry granular product containing 22% of the active ingredient, a 25% pellet formulation, and as a liquid concentrate containing 3 lb/gal of Urab. The liquid concentrate is formulated primarily for use with oil carriers, but it is water emulsifiable at rates of 1 to 7 gallons in 100 gallons of water.

The rate of Urab required to control brush, and the length of time necessary for the herbicide to take effect depends upon the species, age, and growing stage of the brush to be controlled, soil type, soil moisture at the time of application, rainfall following application, type of formulation and method of application used. Urab granular or pellets are generally used at rates of 80-120 lb/A (product) broadcast evenly over the area to be treated or as spot and basal applications at 1-3 oz. per clump. The liquid concentrate formulation is used at rates of 6-9 gpa (product) diluted in enough water or oil (kerosene, fuel oil, diesel oil or aromatic weed oil) to give good coverage. Approximately 75-150 gpa is needed, depending on the size and density of the brush In spot or basal applications, 2-3 tablespoons (1-1½ fluid oz.) of undiluted liquid concentrate are used per clump, depending on the size of the clump, or the liquid formulation may be diluted at the rate of 1 qt/5 gal of water or oil and applied evenly to the base or root area of the plant at the rate of ½ to 1½ pt/clump.

The liquid concentrate applied at rates of 4-5 gpa (product) diluted in sufficient oil or water to give good coverage effectively controls cattails in drainage ditches.

Reports (Southern Weed Conference, 1960) from Texas, Tennessee, Florida, and North Carolina, indicate that Urab is effective against persimmon, running live oak, post oak, hickory, maple, sourwood, dogwood, shortleaf pine, wild cotton, and trumpet vine. Wild cherry, birch, sassafras, sumac, oaks, willow, and poplar are among the more susceptible wood species, but promising results have been obtained on the hard to kill red maple, conifers, locust, elm, bush honeysuckle, and briars.

Urab is an effective herbicide for control of brush on utility, highway and railroad rights-of-way, particularly where regrowth of grass cover is desired. It is also an effective tool for control of undersirable woody plants in fence rows, drainage ditches and other noncultivated areas. Both soil and foliar applications are effective and the results obtained vary with the dosage used, species of brush, soil type, weather conditions, type of application, etc.

[1] General Chemical Division, Allied Chemical Corp., N.Y., N.Y.

[2] Trade mark of Allied Chemical Corporation

TEN YEARS OF FIRELANE WEED CONTROL[1,2]

Kuntz, J. E.,[3] R. Dosen,[4] and A. J. Riker[5]

Weed growth in forest firelanes and access roads of central Wisconsin constitutes a serious fire hazard and greatly reduces their effectiveness as firebreaks. Moderately dense weed populations in the deep, infertile Plainfield sand include both annual and perennial species. Although winter and spring moisture usually are adequate, midsummer rainfall often is limiting.[6] Repeated rototillings have destroyed most of the humus in the top soil. Weed control annually by mechanical means, such as mowing, plowing, disking, or rototilling,

has critical limitations including high costs, vigorous plant regrowth, and possible soil erosion. These procedures may even aggravate the problem. In this area, firelanes commonly intersect at ½ mile intervals both natural and planted stands. Since 1948, many different herbicides, alone and in various combinations, have been tested. Soil sterilants with long residual effects have received special attention. A search has been made for a treatment which, as a single application, would eliminate all or nearly all weeds and grass for several seasons.

Selected herbicides were screened initially on randomized and replicated plots 1 sq rd in area. Most materials were applied in water at 200 gal/A with knapsack sprayers. Promising treatments were retested on replicated 1/10 A plots. A small, motor-driven, boom sprayer was used. Successful treatments were repeated at different dates in the same and subsequent years. Final tests involved treatment of several miles of firelanes.

Of the numerous herbicides used alone and in combinations and at various concentrations (above, at, and below generally recommended rates), many (as AMS, PCP, PBA, $CaCl_2$, NaCl, 2,4-D, endothal and others) failed to control weeds satisfactorily through 1 season. Several (as CIPC, TCA, sodium chlorate, dalapon, erbon, amitrole, and others) gave satisfactory weed control for 1 season, but permitted variable recovery and regrowth the next season. Others (as sodium borate (Borascu), anhydrous borate ore (concentrated Borascu), a CBM (Polybor-chlorate), CBMM's, fenuron, and others) limited weed growth for 2 or even 3 seasons. In the above rough treatment-categories, deep-rooted perennial weeds frequently persisted, especially in low areas, and subsequent weed populations often changed. In most cases, early spring applications resulted in better and longer weed control than did midsummer or fall treatments. Combinations of different herbicides often gave considerably better control than did either herbicide used alone. Original weed stands and weed regrowth following herbicidal treatment were more abundant on rototilled than on non-rototilled firelanes.

A few herbicides have controlled all or nearly all weeds for several years. Monuron at 20 lb/A gave satisfactory weed control for 5 years; at 40 lb/A, for at least 8 years. Generally, diuron proved even more effective and more uniform than did monuron. Commercial applications of diuron at 20 lb/A since 1956 have given excellent (generally bare) and continuing weed control with no retreatment. Little, if any, injury occurred on bordering pines and oaks, although pine transplants and cottonwood cuttings were killed when planted for 3 successive years in the treated firelanes.

Recently, simazine, monuron-TCA, and fenuron-TCA have given promising initial results, but their persistence and residual effects have not yet been evaluated. The last two herbicides, however, have caused severe injury and some mortality to trees and woody shrubs bordering the firelanes. Atrazine at 20 and 30 lb/A permitted considerable regrowth the season after treatment.

It is of interest to compare the firelane results with those obtained with similar treatments in nearby pulpwood storage yards. In such yards, top soils were heaiver and considerable decayed wood waste and humus had accumulated over a period of years. Since yards were located commonly adjacent to rivers, dams, or ponds, water tables were often high, soils remained moist, and weed growth was dense and vigorous. Herbicidal treatments which had given excellent and sustained weed control in nearby firelanes proved wholly inadequate. Although weed populations often changed following treatment, recovery and regrowth occurred rapidly, even by midsummer of the first season. For example, monuron at 30 lb/A controlled most common grasses and weeds, but allowed vigorous growth of ferns, grape, horsetail, spurges, plantain, dandelion, bergamot, and many other weeds. Monuron at 45 and 60 lb/A suppressed most weed growth for 2 seasons, but allowed considerable regrowth the third season. After 4 years, sparse regrowth appeared in plots treated with monuron at 80 lb/A. In contrast diuron at 45 and 60 lb/A gave good initial control with little regrowth after 3 years.

Selection of a satisfactory herbicidal treatment for miles of carefully maintained firelanes will be determined, in part, by the cost of materials and the ease of application. If initial costs, even though high, can be prorated over several years of residual effects, then practical applications seem close at hand.

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[1] Approved by the Associate Director of the Wisconsin Agricultural Experiment Station.

[2] Supported in part by the Wisconsin Conservation Department in cooperation with Nekoosa-Edwards Paper Company and several chemical companies.

[3] Associate Professor, Department of Plant Pathology, University of Wisconsin, Madison, Wisconsin.

[4] Forester, Nekoosa-Edwards Paper Company, Port Edwards, Wisconsin.

[5] Professor, Department of Plant Pathology, University of Wisconsin, Madison, Wisconsin.

[6] In other parts of Wisconsin where summer rainfall is adequate, and ground cover plants remain green, "green-leaf" firebreaks are maintained.

INDUSTRIAL WEED CONTROL

Leo Miles[1]

Weed problems on industrial sites are sometimes difficult to control because of complicating factors found in the soil, as well as the survival and further propagation of difficult-to-control species brought about by previous herbicide treatments. It is in these types of situations that a careful appraisal of the weed problem is necessary in order to use the correct herbicide or combination of herbicides to control the weeds.

Simazine is a soil sterilant herbicide of relatively low water solubility with long residual action, recommended primarily for pre-emergence application. For best results, fall or early spring applications are recommended. Simazine is effective in controlling a wide range of nonwoody annual and perennial broadleaf weeds and grasses at rates ranging from 10-30 lb/A. Simazine has been applied adjacent to shrubs and trees by highway departments with no reported injury to these woody plant species. Simazine applied to soil has very little lateral movement providing the soil it was applied to has not been moved. Simazine has in general been successfully applied to sloping ground and fence lines running parallel to sloping ground with little or no runoff problem.

Atrazine is recommended for pre- or early post-emergence application. Atrazine has a water solubility of 70 ppm compared to simazine which has a water solubility of 5 ppm. The herbicidal action of atrazine is considerably faster than simazine. Unlike simazine, atrazine will burn foliage. Its basic mode of action is primarily by absorption through the plant's root system. Atrazine is effective in controlling a wide range of annual and perennial broadleaf weeds and grasses at from 10-20 lb/A. When runoff or lateral leaching is undesirable such as on slopes or adjacent to desirable trees and shrubs, atrazine is not recommended. Simazine is the preferred herbicide for this type of situation.

Combinations of atrazine or simazine with other herbicides can be used to effectively and economically control weed species not controlled by the triazine herbicides alone. Conversely the addition of simazine and atrazine to systemic, hormone or "knockdown" type herbicides will increase the herbicidal effectiveness of these materials by providing residual action, particularly

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after the systemic, hormone or knockdown herbicides have lost their effectiveness. Where the practice of late post-emergence application of herbicides is followed, especially where a large variety of woody and non-woody plants are present in the population, a combination of atrazine with other types of herbicides provides excellent weed control.

In certain instances where difficult-to-control plant species are present in the weed population, additional applications of a specific herbicide or combination of herbicides will be necessary to control the problem species.

Simazine or atrazine, when used in combination with one or two of the following herbicides, has given excellent weed control when applied post-emergence:

1. Dalapon
2. Amitrole
3. Sodium chlorate formulations
4. Sodium arsenite
5. Pentachlorophenol formulations
6. 2,4-D
7. 2,4,5-T
8. TCA
9. Silvex

The dosage rate of the systemic, hormone or knockdown herbicide generally follows the label recommendations of the manufacturer or formulator. In many cases, an on-the-scene assessment of the weed problem is made and dosage rates of an appropriate herbicide made accordingly. Atrazine or simazine is used in the various combinations at rates of 5-10 lb/A. The amount of atrazine or simazine in the combination is determined by the weed problem, time of application and rainfall distribution.

Atrazine has been successfully applied to railroad yard and branch line trackage at the rate of 10 lb/A. The wettable powder was applied at a concentration of one pound of formulation to one gallon was water, making a total of 12½ gallons of water to apply 12½ lb of formulation (10 lb active) per acre. The formulation was easily maintained in suspension with a recirculation pump. Successful weed control for a full season was achieved from 10 lb/A of atrazine applied early post-emergence to a mixture of annual and perennial broadleaf weeds and grasses.

[1] Geigy Agricultural Chemicals, Ardsley, New York

MODIFICATION OF BASAL TREATMENT TO DETERMINE THE EFFECTS OF HERBICIDE PLACEMENT

Elroy J. Peters and Frank S. Davis[1]

Various opinions have been expressed regarding the site of action of 2,4,5-T (2,4,5-trichlorophenoxyacetic acid) applied as basal treatments to brush. It has been suggested that herbicides applied basally: 1. Move into the plant through the soil; 2. Move on the outside surface of the tree to the bud zone beneath the soil surface and then kill the tree by action in this critical area; or 3. Move into the tree from the area of the trunk to which herbicides were applied and either girdle the tree chemically or are translocated. In this study the following modifications of basal treatments were made to obtain information on the site of action of chemicals: (a) Bud zone:—Treatment so that the spray was directed on the tree at the junction of soil with the tree to get as much solution as possible to the bud zone; (b) Soil protection:—Conventional basal treatment except the soil was protected with a cover to keep the herbicide off the ground; and (c) Collar:—Conventional basal treatment except that the tree was fitted with a collar below the point of application so that herbicide was prevented from running down the surface of the bark to the bud zone. Collars were made of modeling clay and molded so that they fitted the base of the tree to form a cup to prevent the herbicide from running down the tree. Conventional basal treatment was used as a check.

Twenty-five hickory trees (*Carya* spp.), 2 to 6 inches in diameter, were selected for each treatment. The experiment was a randomized complete block design with 3 replications. On April 12, 1958 all treatments except the collar treatment were treated with propylene glycol butyl ether ester of 2,4,5-T at 16 lb aegh of oil. All treatments were applied in oil so that each tree, except in the collar treatment, received 1 gallon of solution per 150 inches of diameter. In the collar treatments the clay collars became soft due to high temperatures and would not hold large volumes of solution. The volume of oil on these treatments was reduced to ½ but the amount of 2,4,5-T applied per inch of diameter remained the same as in other treatments. On May 1, 1959 a second experiment similar to the first was put out except that all treatments received a 2,4,5-T solution of 16 lb aehg of oil put on at the rate of 1 gal per 225 inches of diameter. Applications of herbicides were done with a handgun and timed with a stop watch to control the amount of material that was applied to each tree per inch of diameter.

Where collars were used to prevent herbicides from running down the bark to the bud zone more basal sprouting and less trunk sprouting occurred than with conventional treatment. The reduction in trunk sprouting on trees with collars indicates that 2,4,5-T moves through the bark and is translocated in the trunk. Translocation through the trunk to the bud zone evidently takes place to some extent but not in large enough quantities to prevent large numbers of basal sprouts. Protection of the soil from herbicides did not cause a difference in responses as compared to conventional treatments. The best kill of trees occurred where herbicides were applied to both the trunk and the bud zone.

[1] Research Agronomists, Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, Columbia, Missouri.

Cooperative investigations of the Crops Research Division, Agr. Res. Service, U.S. Dept. of Agri. and the Missouri Agri. Exp. Sta.

COMMERCIAL HIGHWAY APPLICATIONS OF MH FOR GRASS INHIBITION

Wilkerson, J. A., Bohne, P. W., and Morgan, B. S.[1]

Early tests indicated that the sodium salt of maleic hydrazide (MH-40) was effective in suppressing grass growth at 4 and 6 lb/A, but in general were subject to considerable variation.

Later laboratory and field research has shown the diethanolamine salt of maleic hydrazide (MH-30) to be a superior formulation for grass inhibition and to be less subject to plant and climatic variations. Briefly, these data showed the following:

1. MH-30 was absorbed more rapidly under low humidity conditions.
2. Temperature had little or no effect on MH absorption.

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3. MH was found to be inactivated in grass and other plants by forming a complex with sugars.
4. Soil moisture affected absorption of MH quite markedly.
5. Isotope studies showed MH to localize in growing portions of plants.
6. Growng condition and stage of growth of plants affected the MH response.

Studies were conducted with different types of application equipment and nozzles. A low pressure, high capacity, hydraulic sprayer, equipped with off-center nozzles, was most practical for highway use when conditions of high speed of application, safety and clearing of obstructions were considered.

An example of the distribution pattern, determined by chemical analyses of deposits with such equipment, is given in Table 1.

Table 1. New York Highway Department, October 25, 1960, 24 foot median, 50 gal water/A, 10 mph, 10-15 mph gusty wind, Spraying Systems OC-300 nozzle

Feet from truck	Rep. 1 lb MH/A	Rep. 2 lb MH/A
4	5.4	3.9
8	2.4	2.8
12	3.5	2.7
16	5.2	3.3
20	3.1	4.8
Average	3.9	3.5

Mist blower types and hand gun equipment require further evaluation under highway conditions before use of such equipment can be suggested.

A series of tests were conducted to determine the effect of gallonage of water per acre and to evaluate the effect of a simulated light rain three hours after application. The data in Table 2 were obtained.

Table 2. Bethany Laboratory Grass Root Analysis MH 4 lb/A, applied June 10, 1960.

Volume of spray	MH, ppm in roots after 3 wk	8 wk	11 wk
10 gpa			
Unwashed	14.0	24.2	12.2
Washed*	15.0	20.2	14.0
40 gpa			
Unwashed	12.6	—	—
Washed*	8.1	—	—
120 gpa			
Unwashed	10.1	—	—
Washed*	8.0	—	—

* One section of each treatment was washed 3 hours after application with about 0.03 inches of water (200 gal/750 sq ft).

These data would suggest that absorption was quite rapid and rain occurring within 3 hours after application had less effect on the low gallonage than on the higher gallonages per acre. Further tests are planned to determine the effect of gallonage and rainfall after MH treatment.

The 1959 and 1960 commercial highway applications were made on 2000 acres of roadside areas in six states with the following results:

1. Early spring and late fall applications were equal in effectiveness.
2. The optimum dosage for commercial highway grass applications was established at 4 to 6 lb/A.
3. Spraying of actively growing grass was found essential for consistent results.
4. All common highway rights-of-way grasses were found to be reduced in growth by MH applications.
5. Mowings were reduced from 10 and 16 per season to 1 or 2 and in several instances no mowings were required all season.
6. Use of MH showed a marked saving of maintenance funds, particularly when used on hard-to-mow areas, or on areas frequently mowed.

[1] Naugatuck Chemical Division, United States Rubber Company, Chicago, Illinois.

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LUNCHEON PROGRAM

and

PRESENTATION OF AWARDS

PRESIDENT'S ADDRESS

VISITORS TO THE WEED PROBLEM

LeRoy Holm

Will you visualize for the moment that you are a participant and observer at a reunion which is made up largely of young parents who have one or more small children. You will know that in this group there can scarcely be any conversation that does not include "kids"; many claims will be made, there will be much boasting, and many photos of the "results" will be hauled out. If perchance you have had the good or bad fortune to avoid this predicament of parenthood, you will be mystified and perhaps bored with the behavior of your friends. Their fascination and wonder at this new thing which has come into their lives has enveloped them so completely that all else seems secondary as you listen. They are never so interested, well-informed, and expressive when they speak about work, politics, the problems of government, or an uneasy world.

The whole world of these people seems to be in "kids." They withdraw from former friends, their church life is changed, their place in the community is seen through different eyes, and their view of the world and man's place in it is altered. And yet as the children grow and develop they begin to withdraw from their parents whose lives have been changed so markedly by their offspring. Great tensions and strife develop in families as children try to disentangle their lives from those of the parents in order that they may find rightful, independent places in society. As these bonds are weakened and the teen-agers move away to a new world, parents, often with great reluctance, find that the problems of church, education, government, and the world at large are still there. These responsibilities from which they had withdrawn in either large or small measure, from lack of interest or energy "because they were too busy raising a family," are seen to be burdens of which each man and woman must carry his share all of the time. And so they must make still another world for themselves. In our society it is frequently the case with the mother, but sometimes with the father, that contact with society is never again established in a way which can bring any kind of meaningful fulfillment.

In this complex but rather familiar example from our daily lives I see a rather remarkable parallel with a predicament which exists in the study of the weed problem. Surely an untrained observer, if he should visit our conferences, see us at work, read our publications, and know our thoughts, could only decide that our whole world is "herbicides." Surely the wonder of these new substances is worthy of our fascination and we, like the parents, may be excused initially for having been captivated by them. We have been drawn away from the problems of relations between the roots, leaves, and seeds of crops and weeds. We have lost some ties with other disciplines and failed to build bridges to others because of our narrow vision.

We have tried to make a new life with our intense interest in these children; to hold them and keep them as parents do. But we are finding that they are now teen-agers and that they would disentangle themselves from us if the problems are to be solved and if this part of the world of biology is to regain its balance.

There are some who believe that the whole world for us is not the herbicide, but that we have been deceived and have withdrawn from the world to an island where we are now rapidly losing our communication with the rest of biology. It is of my concern with this dilemma that I would speak to you today. My genuine hope is that I may say some things about it which will be specific, and therefore be helpful to you.

A few months ago a young engineer came to speak with us at the University. He came from a company not presently associated with any part of the agricultural enterprise. His company was exploring an idea for agriculture and the engineer had been given the freedom and a suitable period of time to take a cold look at this large and varied industry. He told us that when it was all over, and he had returned to his station to ponder what he had seen, he had been brought to the place where he could only say, "Surely, this is the stone age." We all felt that he was a very perceptive and intelligent individual; we have been thoughtful and have taken seriously his impression of his visit to "our planet." He did not point fingers, but he did see our weed problem. It is worthwhile to reflect about this man's terrible summary of 20th century agriculture, and to ask where it touches our lives in our particular part of the problem.

May I suggest two or three places at which he must have been puzzled:

—As far as we can tell, agriculture went to the pattern of rows several thousand years before the birth of Christ. Weeds apparently drove these early farming operations into rows. They have held much of our production in rows to this date and have been influential in our soil management practices and our cultivation procedures. As a result, many of the machines we have built, and the plants from our breeding programs have had to "fit" rows. Our observer must have asked whether, after thousands of years of row culture, the riches of 20th century science and technology had ever been applied to the problem.

—He must have asked whether the workers who have chosen to study this problem have as their highest goal a period of waiting for the announcement of new chemicals which they may try annually. Many such herbicides come out of a hit-or-miss procedure, some by accident, a very few by design. Most workers are not aware of the manner in which herbicides are selected, they are estranged from such procedures and do not care, and many pay slight attention to the chemistry of the compound itself. It is simply a "thing" to be manipulated.

—The engineer must have looked in wonder at our dirty, expensive, annual fight and asked what our hope is. He must have said, "Why do you wage your fight at the worst of all times—when the crop is there? Can't you see this is not the same as an insect or disease problem?"

At the International Soils Congress this summer, Dr. Frese, who heads the large tillage institute near Hanover in Germany, gave an address to the general assembly. A translation of his title would say this, "Have we a total concept for the scientific work we must do in soils?"

He said in essence, that studies on soil genesis, porosity, compaction, morphology, availability of nutrients, etc., were good and necessary. But he said that the impact of all this on the farmers of Northern Germany is that they have added some fertilizer, but they are still using the same type of plow the Romans had, and that they could seriously ask what all of this soils work is about if it cannot be communicated and interpreted in such a way that it becomes meaningful and useful for

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mankind. He said, in substance, that soils work is full of "specialists," but that there are far too few men and minds big enough to be "generalists." These are the men who will grapple with the total picture of what we have done and what we must do and bring it into focus so that man will find it intelligible.

I do not see a total concept anywhere for an intelligent understanding of the weed problem and all of its implications for agriculture. I know the obstacles we have had, I know the excuses we have offered, and I see only jumbled forays into parts of the problem. We have been visitors to the weed problem.

And I should like to ask what it is that you see when you lift your eyes to the horizons of this part of the biological world which we have claimed for ourselves?

—How many weeds can you think of which have been studied with the kind of precision and detail that is standard for insects, fungi, and bacteria?

—If you feel our great salvation to be in herbicides, where and how do you really think we're going to get the herbicides which are designed for the kind of clean, selective kill which can be delivered with some intelligence, rather than in some mysterious incomprehensible way. For example, we have never really studied the phenomenon of "death" in plants apart from a chemical knock-out. We might find invaluable clues—for death is what we seek. We have never seriously asked whether there are herbicides in nature.

—Do you think farmers are really hopeful that we are gaining on the problem in an absolute way? Or are they—and you—resigned to just another treatment each year? Does anyone seem to have a vision of what agriculture could be without weeds? If you should be feeling very righteous at the moment because a particular chemical (which you did not discover and whose total implications for soil microflora, crop, and weed you perhaps understand only poorly) is clicking in a certain crop, you may or may not feel so in a few more seasons. During a banquet in this hotel just two weeks ago, I sat with twelve vegetable growers from all over America and heard a conversation. The point was made that in a certain vegetable crop there are many good herbicides, and that one of these in particular has been a mainstay for 5 or 6 years. "If only this could be the case in all crops" was his lament! A grower from another state quietly informed the group that folks in his area have slowly given up that particular chemical in the past two years because yields are gradually falling. Across the table, a grower from still another state confirmed this and said no more.

I would ask if Dr. Frese's words may not also apply to us. Surely farmers and our colleagues in nearby professions, when they look to us, must see foremost a sort of mixture of technology and routine testing which is not science and is often not research. They must find, as I do, few men who have real hope that order will come soon, and with it erudite, scholarly goals which have a completeness and a fullness to which a man can give himself with confidence and enthusiasm.

We have been more like visitors to the weed problem —doing what we could do quickly—doing that which was easy.

And yet there are other dimensions of the weed problem, but these are among the most complex in all of biology—and they will be hard. Only a few have tasted them. They will require our time sooner or later simply because our answer does not lie altogether in chemistry. There are so many reasons for this that we could not begin to discuss them here. One instance may show the point and help to keep our orientation. In the work of Harper in England on plant problems, he has shown that one can reduce numbers of plants (in some species) by 90% while seed production is cut only 10%. How many herbicides in 1961 will consistently give better than 90% weed control? And if the other 10% of the weed stand could produce 90% of the season's weed seed supply, how can we believe that we shall ever gain on the problem? These are the kinds of subtle but simple facts which have escaped us because our narrow vision has insisted that living would be better solely through chemistry.

Some of you have studied certain of the other dimensions of the weed problem and a few more have given them serious thought. You will know the difficulty of trying to place or find a "home" for these other aspects of the weed problem in the traditional field of science. One may pursue them from microbiology to genetics, ecology, biochemistry, plant physiology, or other respected discipline. Finally, one may ask seriously whether the study of the total weed problem is not worthy, and sufficiently complex, that it may stand apart as has been the tradition in science. Surely now it seems that the organisms we know as weeds may teach us some things about green plants that we cannot know in any other way.

In spite of the limitations of time, I would like to be more specific about some of the dimensions of the weed problem which are studied only infrequently here in America. There are others, many of them, and I cannot say that my choices suggest any relative importance for these studies over others.

The Weed as an Individual

We have harvested individual plants of *Chenopodium album* from the same 15 ft row at a time when all are in the same fruiting stage. One can find entire plants which are a deep magenta shade, others which are an intense orange, and some which are the normal green color. All may be taken on the same day from rows planted on the same date in spring. We believe these are not just stages through which all plants of this species will pass. It is quite certain that they are of different genetic constitution in much the way that our vegetable varieties differ.

Dr. Buchholtz of our Agronomy Department maintains several clones of quack grass in field and greenhouse which differ very markedly in their appearance and habit of growth.

I have seen the variety trials of Dr. D. Bakker on *Phragmites* near Kampen, in The Netherlands, on the polder most recently drained. This is a weed in America; it is the reed of our marshes. But in Holland *Phragmites* is both a weed and a crop. The seedheads are harvested at the proper time, they are chopped, and are then sown by airplane on those portions of the polder which are emerging. Dr. Bakker, an ecologist, has demonstrated that this plant may thus be used to secure the area against infestations by perennial weeds until agriculture has begun. He has shown, from sorting out several races, that certain of them are able to produce above-ground runners several meters in length during a growing season, while others do not spread rapidly and are thus less useful.

This kind of discrimination between races is necessary in order that we may do our work accurately. At Wageningen, in The Netherlands, several races of *Senecio vulgaris*, groundsel, have been recognized. There are indications that the races respond differently to herbicides. Is it possible that they also have different dormant periods for their seeds?

This work is only beginning. Perhaps it has been done most intensely on *Avena fatua*, wild oats, at the Rothamsted station in England.

Are There Herbicides in Nature?

You are all familiar with the now famous, yet very common, photographs used to show the production of an antibiotic substance by a fungus culture growing on an agar plate which has been inoculated with another fungus or a bacterium. Frequently a clear zone of inhibition is shown where the chemical has diffused out to prevent the growth of other organism(s). This then is truly a view of one organism as it inhibits the growth of another similar organism through the production of an antibiotic—a substance whose structure we can define. Antibiotics are the herbicides of microorganisms!

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I have seen a similar phenomenon on the polders in The Netherlands. Dr. Bakker showed me "holes" or zones of inhibition caused by one green plant when growing in the presence of others. *Catabrosa aquatica*, brookgrass, and *Tussilago farfara*, coltsfoot, are able to exert such an influence in areas where the surrounding lush vegetation, *Phragmites* and *Senecio*, is 1 to 2 meters tall. This effect may be exerted for many months after the plants are gone. By comparison, this represents the inhibition of growth of one organism by another through the production of an unknown substance, or through some means which we do not understand. No one can say why this is so.

Dr. Harper of England has shown that if seedlings of *Leptosyne maritima* are placed on a nutrient agar for for 4 hours and then removed, sufficient toxic chemical is released so that if *S. aureus* is inoculated to the plate, large, clear, zones of inhibition are outlined. He has preliminary evidence for the interference of lettuce root growth by this phytotoxic substance.

Dr. Bode in Geisenheim in West Germany and Dr. Grummer at Griefswald in East Germany have shown that rains may leach toxic substances from leaves and that these may inhibit the growth of crops. The former has shown that the toxic chemical from black walnut is not given off by the roots, but is leached from leaves by rains to the soil and crops below. Grummer has identified some of the substances washed by rain from the leaves of *Camelina alyssum*. This weed, which is similar to our false-flax, commonly grows with flax in Germany and may cause serious yield reductions. The phytotoxic substances are washed onto the leaves and stems of flax, as well as to the soil, and growth inhibition of the crop is the result.

More than thirty years ago, Kooper, a Dutch ecologist working in Java, reported from his experiments that the seeds and seedlings of some weed species seem able to control the germination and early seedling growth of other species. This suggests a kind of domination that we have not thought about. This is another example of a kind of control which is exerted before there can be any competition for light, nutrients, and water.

We are without worthwhile patterns or clues as to what really selective herbicides ought to look like. Perhaps this is the place where we should have looked initially.

The Mutual Influences of Plants Below the Soil Surface

When we become seriously interested in this fascinating world beneath the soil surface, we recognize that our plants may affect one another directly or their influences upon one another may be mediated by the soil microflora. I believe it would be difficult to imagine many instances where the soil organisms do not become involved. Our thoughts about this dynamic world of small plant and animal life must also be informed about the effects of living roots as compared with those which are dead and have become "residues"—as we call them.

Roots are interlopers here. I believe you know that the rhizosphere, the area adjacent to the root, has much higher populations of small organisms. We have long ago accepted the fact that many complex substances are given off by roots, and that biologically active substances are released on the death of roots.

Each species, so far as we know, tends to encourage its own retinue of small forms to develop in its share of the soil—and since the soil has an impoverished diet for its tenants—such "species-specific" organisms, if we may call them that for the moment, will therefore develop at the expense of other forms. If the ever-present weed can alter the balance in its favor—and to the detriment of our crop—we must understand this.

This work is some of the most difficult in biology today. There is much that needs to be done but much has already been accomplished that we ought to be aware of.

Patrick and his co-workers in Canada have studied the problem of residues of specific crops on the growth and development of tobacco. There are many similar studies about the world on this and other crops. I have chosen this excellent work because it demonstrates a very strange phenomenon. Tobacco seeds germinate well and grow to good size in Petri dishes in the first six days. If an extract is made of a soil in which timothy residues have been allowed to decay for 21 days, and if this extract is added to the dish of tobacco seedlings, the root tips become blackened in 1 hour. The region of elongation remains healthy. If, however, the extract is made from rye residues, the root tips remain healthy and the region of elongation becomes black and is seriously injured. This remarkable demonstration of the extreme specificity of these toxins ought to be a reminder to us of the work we have yet to do in our weed-crop relations.

Does it make a difference if the root tips are lost? Some years ago Njoku and Williams in England demonstrated that it makes a disturbing difference in horseradish. Plants were grown for a period of time during which the normal, spear-shaped leaves were developed. The same plants were then treated in such a way that the root tips were cut off as fast as they formed. The leaves which develop subsequently are deeply lobed and spiny in appearance; having an appearance which is scarcely like that of the normal leaves. If this is the response of a large, rugged plant such as horseradish, a seedling may surely suffer greater loss if subjected to the loss of its root tips.

We may not hurriedly dismiss these as "laboratory experiments" before they frighten us. It would seem to require that we now must do the work called for before we may say that these phenomena are not operative in agriculture. Patrick estimates that the concentrations used in his extracts would approximate those in the field. Further, tobacco growers have known all too well for decades the result of planting tobacco in an improper rotation.

Welbank working at Rothamsted has recently shown that extracts of the residues of quack grass roots or rhizomes which have been allowed to decay in a sandy soil for 15 and 22 days are very toxic to growing rape seedlings. The active substances from rhizomes were much more severe, and their potency increased from 15 to 22 days. Welbank used about the same amount of quack grass residues which were to be found in quack-grass infested soils in agriculture.

The Mutual Influences of the Seeds and Seedlings of Crops and Weeds

It is my belief that this is at present one of the most barren areas in all of weed research. Some time ago, two members of our group, Mr. Rake and Dr. Garimorth, noticed a species difference in the reduction of beet stands by weeds. They were working on weed competition and had planted in the field narrow bands of single species of weeds such as *Amaranthus retroflexus, Chenopodium album, Setaria viridis, Digitaria sanguinalis* and others. Into this band, and at about the same time, red beets were planted. Careful observation during the hours of germination and emergence revealed that there was a serious reduction in beet stand in the bands seeded with *Amaranthus*. All of this occurred before any of the plants were more than 1 in high. Measurements were taken on a sizeable area and it was found that none of of the species were toxic to the young seedlings except *Amaranthus*, but in the area where the latter was growing, 50% of the beet seedlings were killed. No one can say why this is so, but we ought to ask ourselves whether this occurs often in agriculture without our knowledge? Perhaps more pertinent to this discussion is the query concerning the number of times this has been observed by farmers and scientists who have simply dismissed it as a "poor stand." We have often seen weed stands in farmer's fields which were as severe as those which killed the beets. And because this occurs so early, there is no hope of explaining the disaster in terms of light, nutrients, and water.

But there are many ways to speculate about why the beets were killed. One of the interesting aspects of the problem is that the effect may have been mediated

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by microorganisms. Mr. Rake and Mr. Gressel have demonstrated the possibility of this by seeding tobacco and weeds together under sterile and non-sterile conditions. In one experiment tobacco was seeded in a greenhouse soil in plastic pans without sterilization of the medium. A comparable set were sterilized. The tobacco grew well and there was a good stand in both the sterile and non-sterile pans. Now when seeds of pigweed, *Amaranthus retroflexus*, and foxtail, *Setaria viridis* were planted with the tobacco under both conditions, a luxuriant fungal growth developed in the unsterilized pans. The result of this was that all of the tobacco and most of the weed seedlings were destroyed before any of the plants were more than 1½ in high. In the sterile pan a heavy carpet of weed seedlings was produced. When these were pulled out very carefully it was seen that a very fine stand of tobacco seedlings was growing vigorously below the weed canopy. At this stage, when the weeds were 2 in high, it seems likely that active competition for nutrients, light, and water may begin. In the unsterilized pans there never could be competition for these major elements of the environment, for the battle for survival was over before any such struggle could begin.

Our traditions and accumulated works on light, nutrients, and water are so massive that we can see beyond them only with great effort, but in a total concept of plant competition, the battle may very often be decided long before "the big, cumbersome three" can gather their forces. But we as weed researchers have not seriously asked this question.

These are some of the other dimensions of the weed problem in agriculture. There is no need to take the extreme view that every plant is a positive aggressor wherever it grows and that it is rich in toxic new substances. We know that Nature is never this consistent about anything she does. Only a small measure of the same kind of logic is needed, however, to see that Mother Nature may not be expected to provide the other extreme—a world of plants which are all completely innocuous. Between these we will find her pattern and we will know it only when we shall finally consent to labor over her individual species.

Men looked with unseeing eyes at antibiotics for centuries until these substances stood up in their midst and demanded to be recognized in 1940. Before this time, no prophet would have dared to describe the magic which these substances have brought to our use of drugs in 1960. I wonder why we have not been serious about these same phenomena in the world where we work. Miss Brenchley of England said almost 50 years ago that *Alopecurus agrestis* was actively aggressive against wheat in such a way that even after the weed was removed, the "deleterious factor" was still influential and prevented the development of the wheat. The many excellent reviews of such studies in the past two decades have invariably closed with a paragraph informing the reader that there is no direct evidence at present for "allelopathy"—the effect of one plant upon another. It would appear that the evidence is at hand; it is only the work which will be required henceforth.

In closing, I would express my conviction about the future of "weeds in agriculture," and what we must do about them, by drawing a parallel with "men in society." We are aware from our experience of living in a community that many of our problems stem from the inadequacies of the *individual man*—and his overt attempts at evil and selfishness. Mass attacks on evil, alcoholism, or selfishness have often resulted in only the making of noise. When on the other hand, society has sought to undo the wickedness of man by dealing with him as an *individual person*, by relieving his tensions, and by understanding him, it has at least recognized that this is the source of the evil—the *source* of our problems—in our community and in society.

So it is with the weed—in agriculture. It is one of the basic causes of inefficiency. Unspecific mass attacks on "weeds in general" with toxic chemicals seem doomed to a low level of success because they do not recognize *the source of the problem*—the individual weed species and our failure to understand it.

Dr. Frits Went was invited to speak to us in this conference in this city just ten years ago—almost to the day. He warned us then, and challenged us, that we must do these things and not become distracted. I urge all of you to read his address in the Proceedings of 1950—and be thoughtful about what we have done with our time—ten years of it.

I believe we must do all this simply because it is the only way to acquire the wisdom to know how, when, where, but perhaps most important of all *whether*, we shall use herbicides. I believe that any other pathway will be the longest way 'round—and will include much sightseeing.

Until now, we have for the most part, been satisfied, and surfeited, like the honeybee, with visitations to those places where the nectar is the sweetest, and the haul is the shortest.

Professor Harley J. Otto of The University of Minnesota, Chairman of the Essay Contest Committee, announced that the winner of the 1960 Essay Contest was Cheryl Elaine Orr, age 16, of Carberry, Manitoba. Her paper follows.

HOW WE CONTROL WEEDS ON OUR FARM

Cheryl Elaine Orr

My family's objective is to own and maintain a weed-free, productive farm. This has led four generations of my family in the endless struggle to erradicate and control weeds on our farm. Most urban people believe that spring plowing, weed spraying, and summerfallow are the only usual means of controlling weeds. This is only half the story! We do not employ a system of spasmodic attacks on insurgent weed pestilences, enemies of our soil. On the contrary, Dad's plan of control continues to operate throughout the four seasons of each year.

As the first breath of spring is wafted on the billowy wings of a late winter chinook, Father begins to plan his fields of grain. The first step invariably, is to clean and treat his seed wheat and oats. Our seed is cleaned at home, and is therefore not exposed to the danger of contamination by various weeds spread through the public use of grain elevator cleaning facilities. Dad usually manages to snaffle Mum's vaccum to remove lurking weed seeds from the seeder. Grain and seeder clean, he patiently waits for April showers to bring forth May flowers . . . and weeds. As the spring winds dry the snow water from our fields, Dad commences to plow under any weeds which germinated in the fall and survived the winter cold. After the land has been cultivated, it is seeded. In conjunction with this operation, fertilizer is spread. This encourages the grain to outgrow and smother weeds. On our farm wheat and oats are grown exclusively for our stock. Naturally the wheat is sown on the previous year's summerfallow which has collected moisture, and through cultivation is weed-free. The seeding of oats, which mature early, is usually delayed, in order to promote a good germination of weeds before cultivation. Often the freshly seeded fields are harrowed to kill any shallow rooted seedlings. As a further measure of control, chemical weed killers are sprayed before the grain is too advanced. Soon spring blends into summer.

In the warm summer, sun and showers cause the tender grasses and legumes to flourish. Weeds also enjoy the tender mercies of Nature, and they too flourish. Still bearing in mind the necessity of controlling weeds, Father proceeds to gather winter feed for our herd of Angus cattle. He takes advantage of the process of making silage to cure our corn and clover. Weed seeds from these fields are sterilized when the silage becomes heated. Thus, the possibility of reinfesting the fields with

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weed seeds from the manure spread is ruled out. Incidentally, while cutting silage Father runs the cutter around the fence line. While he thus gains additional hay, he eradicates many weeds. Generally our roadsides are mowed before the weeds are very advanced. Besides cutting down weeds, this measure helps to prevent snow from banking over the road in winter. We also make a habit of noting noxious weeds growing on the roadside and of reporting them to our weed inspector. They are then sprayed with weed killer. We once noted a patch of leafy spurge growing on what had been the butt of a hay stack in the pasture. Dad intended to replenish the salt lick, so he placed it on the infested spot. The combination of saline saturation and trampling by many hooves completely killed this noxious vandal. Not so succesful is his battle with thistles, which plague some of our fields. Because they do not start to grow early in the spring, Dad is able to retard the flowering and seed-setting of thistles considerably by the competition offered through sowing fast-growing cereal oats. These methods, along with maintaining summerfallow, complete our summer program of weed control.

As the days become shorter, our plump golden wheat undulates gently in the crisp autumn breeze. Before many days the swathing and combining commence. My brothers, sister, and I often have the task assigned us of sweeping out the granary bins before they are filled. While harvesting, Father likes to have the combine swept off between fields, especially if he is doing custom work for neighbors. With this precaution taken, a minimum of weed seeds off the combine are spread from field to field. Dad also realizes the prudence of using a tarpaulin over the truck box when transporting grain from the granaries to the elevator. This prevents the spread of weed seeds which, because they are lighter than grain, inevitably reach the top of the truck and could easily be blown about. When the combining is completed, Dad plows the stubble down, thus discouraging fall germination of weed seeds which might survive the winter months.

When the first fluttering snow falls to the earth, we herd our cattle home from summer pasture. They consume approximately ten thousand bales of hay in one winter. Fancy the possibilities of weed infestation from this source when manure is spread over our fields as fertilizer! However, Dad averts the infestation by loose-housing most of our cattle during the winter months. The weed seeds remaining in the manure become packed, heated, and sterilized. Manure spread from the barn, where fattening steers and cows with young calves are grain fed in conventional stalls, does not present this hazard either, because Father feeds the grain crushed as chop. It is evident to me that even while Mother Nature blankets her Child with a shimmering eiderdown of snow, to rest, Father is ever mindful of the hazard of replanting fertile weed seeds.

With the waning of winter and the reappearance of the first feathered harbinger of spring, another cycle of weed control commences. If winter comes, can spring be far behind? If spring comes, can the reappearance of weeds be far behind?

Mr. Clinton Zinter of F. H. Peavey & Co., Chairman of the Industry Divsion, announced the winners of the County Awards. The winner of the award for Outstanding Extension Worker was Warren K. Olson, County Extension Agent, McLean County, North Dakota, and for Outstanding Regulatory Worker was W. E. Folken, Weed and Seed Inspector, Elbow Lake, Grant County, Minnesota. Their reports follow.

ACTIVITIES FOR 1960

Warren K. Olson[1]

McLean County, Central N. Dakota—67 Townships—32 organized and 35 unorganized. Primarily Williams loam soil with 15 to 18 inches of rainfall annually. Over 800,000 acres of crop land and 400,000 acres of range land.

Our weed control program is a part of our overall extension program. We do not have a state weed commissioner and therefore have no state or county regulatory agent or weed commissioner. The organized weed control work at the present time is done through our office with the cooperation of the County Commissioners.

Our work is primarily educational. Through our mass media means of communication we attempt to inform our people. Local newspapers, radio, and farm meetings have been used extensively. Personal farm calls have been used as much as possible as well as visits with our chemical dealers.

We have a very active 4-H club program which includes considerable time in crops work. We have felt that one of the first steps to weed control is to be able to identify the weeds. This may sound very basic, but it is surprising to find a large number of people who cannot identify the very common weeds of our area. We have spent considerable time with identification of weeds in our 4-H work and also use it at adult meetings.

Our demonstration programs include a number of plots of various chemicals for control of leafy spurge, creeping jenny, and wild oats. We have cooperated with, and received excellent cooperation from, chemical companies and their representatives. During the past few years we have had trial plots for wild oats, creeping jenny, and leafy spurge as well as a chemical summer fallow trial. These have been observed by many of our farm people.

Our Extension Agronomist has made available to us small samples of new chemicals for trial plots. This tends to keep us aware of new chemicals and when they are proved for general use we can proceed with confidence.

The farmers of our area are very progressive and adopt new ideas and practices very fast. The overall general farm weed control has been excellent. We still have our problems, but recommended practices are used extensively.

Through the cooperation of an excellent board of County Commissioners, we have a roadside weed control program that has been operating about seven years. The county operates a sprayer mounted on a jeep and as needed hires additional sprayers to cover the approximately 700 miles of county roads. The primary aim of the program has been to kill or suppress the weed growth until a good stand of grass can be established.

During the past three years we have undertaken three programs in roadside weed control. The county commissioners, and Highway Engineer are cooperating and financing the projects. Briefly, these are leafy spurge eradication, roadside spraying and willow spraying.

The leafy spurge program includes the operation of the county sprayer on all patches of spurge on county right-of-way, and the furnishing of herbicide to any landowner free of charge for spurge control on his farm. We have a small amount of leafy spurge in our area and the program is proceeding satisfactorily.

The new roadside weed control program involves killing all growth on a two foot section of the shoulder of the road. This is a trial program in which 50 miles of road were sprayed and will be checked as to cost and effectiveness of control.

We have approximately 150 miles of road ditches with small patches of common willow causing a serious snow problem. Each year county crews have to be sent out to cut the most serious areas. This year we started a program of willow spraying which we hope will eventually eliminate this problem.

We have had excellent cooperation from our farm people, County Commissioners, County Engineer, and chemical dealers.

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Our program is planned by our County Commissioners and extension planning committee. We believe that if you have a program that is really needed, cooperation of the people involved will be easy to secure.

We have our problems and we have made mistakes. We need a workable weed law that will be accepted by the people. We have a long way to go on this problem.

Labor, equipment and finances are always a problem. We need help at the state level to carry on adequate research on the use of chemicals in our area, on our land, our climatic conditions and our weeds.

The addition of new herbicides each year make our program one that must be continous. Many of our new chemicals are more critical in their application than those we have been using and require more intensive educational work.

We have worked hard on the control of weeds in our area, but have barely scratched the surface as to what needs to be done.

[1] County Extension Agent, McLean Co., South Dakota

ACTIVITIES FOR 1960

W. E. Folken[1]

Our present program of weed and seed control in Grant County, Minnesota is the result of a conference between Mr. Sig. Bjerken, Supervisor, Section of Weed Control, Division of Plant Industry of The State of Minnesota, The Extension Service, and The Grant County Board of Commissioners. The net result of this conference was that weed and seed control should be approached as a community problem rather than an individual problem. This conference took place about twenty years ago and I find that this approach to regulatory control in my area has served us quite well over the years. This is the basis which has been used to build our present program of weed and seed control and this is the basis which I am using to strengthen our program for the future.

One of the ways I use to accomplish this community support is to delegate some of the responsibilities for regulatory control, to the different Townboard Members. Some of these responsibilities include such things as:—seasonal inspection of growing crops, signing of all newsletters in their respective Township, weed control on their respective Township roads and attending The Annual County Plant Industry Conference. This arrangement tends to put weed control on the local level as Townboard Members are looked upon as leaders of their respective communities. This arrangement is essential when selling weed control and indeed selling is what puts across an effective weed control program. Thus The Townboard Members are a vital link in our weed control program.

With today's high production costs it is essential that the farmer be aware of the newer methods of weed control. This, I feel, is all important. The right information is very essential. There are several methods that can be used to accomplish this. One of the most effective methods that I have found, in this field of information, is that every farmer in Grant County receives a news-letter every year, on weed control. This arrangement, I feel, tends to remind the farmer that weed control should be considered before he actually has planted the crop. Many farmers and they are sincere think they can buy eradication of weeds, when they purchase weedicide, rather than control. These letters, which are signed by the Townboard Members, we stress the responsibility the citizens of the Township have entrusted in their Townboard Members to see that good weed control is carried out in their respective Townships. Then we go on to say, "we are sure that you will want to cooperate with us in this effort". This phrase, I feel, has sold more weed control than any police action could possibly have accomplished. This approach, to weed control, tends to make people aware of the fact that they have a moral obligation to their neighbor, in weed control. Another effective method, which I use, is the use of timely news articles, of current interest, in all local papers. Selling cooperation is another vital link in our Grant County Weed and Seed Control Program.

Through the foresight of my County Board I have another tool I use to promote good weed control, in Grant County. One of these tools is full time employment. Thus I can and do remind the people, of Grant County, they have a service available to them in their Inspector. People do like and expect service on the individual basis. This full time arrangement allows me to visit chemical dealers, seed dealers and elevator operators as well as farmers. Through these visits some small service is often performed which promotes much better public relations. Public relations, in regulatory weed control, is a must. This full time employment makes it possible for me attend meetings and conferences with some time available for study so as to be better qualified to deal with every day problems. New chemicals are on the market every year for some newer method of weed control. It is essential that I be well enough informed to answer questions arising from the use of these newer chemicals. I take the position that, "no advice is better than the wrong advice". This full time employment makes it possible for me to spend some time, during the winter months, on seed testing for the farmer. Without this service seed testing, by the farmer, would most certainly lag. This is a field that has its place in good weed control. Certainly, weed control is no better than the seed planted. In the field of noxious weed control, such as leafy spurge, we have a service for the people of Grant County. I like to look at this service as a community project. I may add we have considerable leafy spurge. This feature of our weed control program, I think, is unique in that all taxpayers share in its control. With a program of this nature there is no charge, to the individual, for truck hire or labor. Chemical is sold to the individual for actual cost. Thus all taxpayers have some responsibility in the control of noxious weeds, such as leafy spurge. I like to borrow the phrase:—"if we all work together" weeds need not be a problem.

[1] Weed and Seed Inspector, Elbow Lake, Grant County, Minnesota.

Dr. C. J. Willard of The Ohio State University, Chairman of the Committee on Honorary Membership, introduced Professor Oliver C. Lee of Indiana as an Honorary Member of the Conference, and presented him with a scroll.

Our honorary member for this year is one of the best of Americans, but he was born in Bergen, Norway. He is still vigorously active in NCWCC and elsewhere, yet he is one of less than half a dozen men who have attended every meeting of the NCWCC, from 1944 to this noon.

He has done so much good weed research (on a part-time basis) that most of the Conference, if asked off-hand, would classify him with the Research group, yet he has been an Extension Weed Specialist longer than any other man in the United States. His state had the foresight to appoint him to that position in 1929, fifteen years before 2,4-D, when there were not over five men in the United States giving full time to weed problems, and no other state had an Extension specialist in that field.

Our new honorary member has been President of the Conference. He has been Director for his state from the organization of the Conference to the present, except for the year he was President. He was Secretary-Treasurer for two years. He has been chairman of many committees, and a member of many more. He has made repeated notable contributions to our program.

On the Board of Directors he has been a quiet, constructive leader—always thinking ahead as to what

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would be best for the Conference. In his home state, he has developed an outstanding Extension program on weed control. It is with the greatest professional and personal pleasure that I announce the selection of Oliver C. Lee of Indiana as an Honorary Member of the North Central Weed Control Conference.

HONORARY MEMBERS NORTH CENTRAL WEED CONTROL CONFERENCE

These are the Honorary Members of the NCWCC:

1948 L. W. Kephart
1949 A. H. Larson
1950 J. Walter Zahnley
1951 Posthumous citations of T. R. Yost and R. F. Fuelleman
1952 Henry E. Wood
1953 Walter C. Dutton, George Briggs
1954 A. L. Bakke
1955 C. J. Willard
1956 R. S. Dunham
1957 P. J. Olson
1958 L. W. Melander and posthumous citation of T. K. Pavlychenko
1959 E. A. Helgeson
1960 O. C. Lee

AMENDMENTS TO BYLAWS

Bylaw IV. Officers, of the North Central Weed Control Conference was amended at the December 12 meeting of the Board of Directors to read as follows:

Section 1. The officers of the conference shall be a President, a Vice President, a Secretary-Treasurer, an Editor, and a Member of the Executive Committee of the Weed Society of America. The officers shall be elected by the outgoing board from the active membership of the conference. The Editor and the Secretary-Treasurer shall hold office at their pleasure.

Section 2. An Executive Committee composed of the President (who shall be chairman), the Vice President, the Secretary-Treasurer, the Editor, and the Member of the Executive Committee of the Weed Society of America, shall conduct the business and affairs of the conference during the intervals between the gathered meetings of the board of directors. This committee shall have such other authority with respect to the affairs of the corporation as the members of the corporation may determine and/or as provided in the bylaws.

Section 3. The Member of the Executive Committee of the Weed Society of America shall be elected, at specified times, for a four-year term, except for the first Member elected, who will serve for only two years.

Section 4. Duly elected officers become members of the board of directors. The President shall act as chairman of the board.

The Bylaws of the NCWCC were printed in the Proceedings, 18:61.

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RESOLUTIONS

NORTH CENTRAL WEED CONTROL CONFERENCE, INC.

MILWAUKEE, WISCONSIN, 1960

Whereas, the passing of Mr. John Hutchison has deprived the NCWCC of a competent and sincere worker; and

Whereas, we individually and as a Conference organization will miss him and his support of our work: Therefore be it

Resolved, That we express our deep regret at his passing and extend to his family and close professional associates our deepest sympathy; and be it further

Resolved, That this resolution be placed in the minutes of this organization and that the secretary be instructed to transmit a copy of this resolution to his family and to the officials of the Noxious Weeds Division, Kansas State Board of Agriculture.

Whereas, the NCWCC appreciates the arrangements that have been made and the excellent facilities provided for this 17th annual meeting: Now, therefore, be it

Resolved, That we express our thanks to the State of Wisconsin, the City of Milwaukee and to the members of the Local Arrangements Committee: L. G. Holm, B. G. Johnson, M. N. Dana, T. W. Tibbitts, K. P. Buchholtz; J. E. Kuntz, and D. R. Peterson, Chairman. Furthermore, be it

Resolved, That the Conference expresses its thanks to the Midwest Farm Paper Unit for providing the excellent printed program. Furthermore, be it

Resolved, That the Conference expresses its thanks and appreciation to all others who have participated in making the Conference program a success.

The following resolution was submitted by the Regulatory group, and adopted by the Board of Directors:

Whereas, Canadian weed workers are carrying out an effective weed control program in their area and in some cases on the U. S. side, nothing is being done on soil bank land as well as on other lands that are badly infested with leafy spurge and other noxious weeds, immediate steps should be taken to establish a cooperative weed control program between proper Canadian and U. S. weed officials. Therefore, be it

Resolved, That the NCWCC officials notify proper authorities in Washington, D. C. regarding this matter.

Meetings of the Board of Directors

Hotel Schroeder, Milwaukee, Wisconsin

Abstracts of the Minutes

December 12, 1960

Twenty-four Directors were present. The Editorial, Local Arrangements, and Research Committees made routine reports.

Cheryl Elaine Orr, 16 years old, of Carberry, Manitoba, was announced by the Essay Committee as the winner of the essay contest.

The Industry Committee reported wide participation in the essay contest, and proposed awarding certificates to non-winners. Voted to award certificates to winners of second and third places, and a plaque to the winner of first place. The certificate holders may compete another year.

Seven of the 17 states and provinces have not participated in the essay contest in the seven years it has been conducted; Illinois, Indiana, Iowa, Kentucky, Ohio, Oklahoma and North Dakota. Michigan has participated once; Kansas twice; Minnesota 4 years; Missouri 5 years; Alberta, Nebraska, South Dakota, and Wisconsin, 6 years; and Saskatchewan and Manitoba, 7 years.

The Extension Committee reported that 5 states participated in the outstanding extension worker award, and that Warren K. Olsen, Washburn, North Dakota, had been selected for the award.

The Regulatory Committee reported that there were six entries for the outstanding regulatory worker award and that Walter Falken, Elbow Lake, Minnesota, had been chosen.

The Nominating Committee nominated J. D. Furrer for Secretary-Treasurer, Sig Bjerken for Vice-President, and E. K. Alban for President. Each was elected to the office named.

The Honorary Membership Committee recommended the selection of Oliver C. Lee as an Honorary Member.

President Holm proposed a new Bylaw IV of 4 sections to replace the previous Bylaw IV (NCWCC Proceedings 16:61). It was adopted (printed on page 000).

The Future Meetings committee reported that the NCWCC will be host to the Weed Society of America in St. Louis, December 11 to 14, 1961. The 1962 meeting will be held in St. Paul, Minnesota, December 3, 4, and 5; there will be no 1963 meeting; the 1964 meetings are scheduled at East Lansing, Michigan.

Arrangements for the St. Louis meeting were announced. Each organization will meet its own expenses, and the balance or deficit will be equally divided.

A search of the minutes revealed that the Conference had not lived up to an action of the Board regarding payment of the Secretary-Treasurer. It was voted to pay the amounts due previous Secretary-Treasurers in full.

December 14, 1960

Directors from Michigan, Oklahoma, and Canada Department of Agriculture were absent.

The Treasurer's report showed a loss of $195.31 on 1960 operations. The net worth of the Conference on November 30 was $15,496.

D. D. Hemphill was elected NCWCC Representative on the Executive Committee of the Weed Society of America.

The Research Committee announced that it would meet in 1961 at St. Louis.

The Resolutions and Necrology Committee submitted the resolutions printed on Page 000, which were adopted.

The Publications Committee presented recommendations, largely based on those from a special sub-committee of the Research Committee, concerning Conference publications. These were adopted. The Research Report is to be published annually, separately from the Proceedings, which will be a biennial. The Editor will mail the Research Report by January 10. There will be no Proceedings in 1961. Thereafter, either full length papers or abstracts, to be so designated, will be published in the Proceeding, but no illustrations will be included. The Research Committee will prepare in 1961 a "Summary of Research Findings, 1958 to date" as part of the Research Report. The Research Summaries prepared in 1958 will be revised in 1962 and printed in the Proceedings.

The Research Reports and Proceedings from 1944 through 1956 are to be reproduced by some photographic process to put the records in permanent form.

The Regulatory Committee submitted a resolution concerning weed control on soil bank and other lands, which was adopted. (Page 000.)

It was voted to continue the essay contest, Regulatory, and Extension awards in 1961.

XUM

RESEARCH REPORTS

ANNUAL, WINTER ANNUAL, AND BIENNIAL WEEDS
WILD OATS

Avadex (2,3-dichloroallyl diisopropylthiolcarbamate) as a pre-planting herbicide for wild oat control in barley. Carder, A.C. On April 28, 1960, an area of good soil in fall-plowed wheat stubble and heavily contaminated with a natural infestation of wild oats was harrowed, sprayed and the chemical incorporated immediately. Spraying was done by boom plot sprayer on triplicated 2-sq-rod plots. Two incorporation methods were used: a single working with a double-disc harrow, and a double working, the second crosswise to the first. Weather was calm, warm and bright. One week later the area was planted to Olli barley. Satisfactory soil moisture induced good crop establishment and a first germination of wild oats. About a week after crop emergence heavy rains over a 6-week period induced further germinations of wild oats. Procedure details and results are given in the table.

Avadex lb/A	Unfertilized					40 lb/A 11-48-0				
	Single incorporation		Double incorporation			Single incorporation		Double incorporation		
	10 gal/A water	20 gal/A water	10 gal/A water	20 gal/A water	Av.	10 gal/A water	20 gal/A water	10 gal/A water	20 gal/A water	Av.
	Yield wild oats, bu/A*									
0	7.9	11.7	17.3	18.0	13.7	9.2	11.9	20.0	22.1	15.8
1	2.5	1.1	3.0	4.2	2.7	1.4	1.3	2.1	4.3	2.3
1½	1.9	1.2	2.1	3.2	2.1	2.3	1.5	2.5	2.3	2.2
2	1.2	1.1	1.2	1.7	1.3	1.2	2.1	1.2	1.4	1.5
	Per cent reduction by Avadex									
1	68	90	83	77	80	85	89	90	81	86
1½	75	89	88	82	84	75	87	87	89	86
2	85	90	93	91	91	87	82	94	94	91
	Yield barley, bu/A									
0	30.7	24.5	30.0	31.8	29.2	46.7	40.8	47.5	48.2	45.8
1	36.0	28.3	39.0	45.0	37.0	54.4	48.5	58.1	62.0	55.7
1½	29.8	31.0	40.8	41.9	35.9	51.1	52.4	57.2	61.4	55.5
2	33.4	32.4	35.1	38.0	34.7	49.4	48.0	54.5	64.8	54.2
	Per cent increase by Avadex									
1	17	16	30	41	27	17	19	22	28	22
1½	—3	27	36	32	23	9	28	20	27	21
2	9	33	17	19	19	6	18	15	34	18

* Cleaned from grain plus shattered.

The data indicate that: 1) Fertilizer did not offer a measure of wild oat control. 2) The effect of Avadex in both unfertilized and fertilized series of plots was similar; 1 lb/A giving at least 80% control (av. all plots), 1½ lb/A giving 85% and 2 lb/A giving just over 90% control. 3) Doubling the volume of water and doubling the incorporation gave inconsistent results but each had a slight tendency (about 3-4%, basis all plots) to reduce wild oat numbers. 4) Fertilizer increased yield of barley 50%, basis all plots. 5) Effect of Avadex on yield of barley by removing wild oat competition was similar for both unfertilized and fertilized series of plots. 1 lb/A of Avadex increased yields 25%, basis all plots. The heavier rates of Avadex resulted in slightly reduced increases, particularly the 2 lb/A rate, probably because of the injurious effect of the herbicide on the barley. Thinning of stand was noted early in the season from use of 1½ and 2 lb/A, especially the latter. 6) Fertilizer plus 1 lb/A Avadex increased yield of barley over the unfertilized, non-treated plots by 90%. 7) Increasing the gallonage of water and doubling the incorporation gave inconsistent results but each tended to a slight general increase in yield of barley (10%, basis all plots), presumably by increasing somewhat the effectiveness of Avadex. 8) Avadex had no marked effect on maturation of the barley even at the heavier rates, but fertilizer advanced ripening 5 days. (Canada Agriculture, Experimental Farm, Beaverlodge, Alberta.)

Barban (Carbyne) as a post-emergence herbicide for wild oat control in spring wheat. Carder, A.C. On May 6, 1960, an area of good soil which was in summerfallow the previous year and heavily contaminated with a natural infestation of wild oats was cultivated, harrowed, and sown to Saunders wheat. Soil moisture was good and the crop established itself well, along with a heavy first germination of wild oats. About a week after crop emergence heavy rains over a 6-week period induced further germinations of wild oats. The fact that wild oats germinated from different depths and over a considerable period of time made it impossible to apply barban when seedlings were at a common developmental stage. Thus, the first application of barban was made when the majority of the wild oats were considered to be in the 1½-2 leaf stage, although at this time some seedlings were just emerging while others had reached the 3-leaf stage. Likewise, the second application was made when the majority of wild oats were in the 2½-3 leaf stage, but stages from 1 to 5 were represented. Spraying was done by boom plot sprayer on triplicated 9 x 30 ft plots. Weather at times of spraying was calm, warm, and bright. Soil moisture was abundant. Procedure and results are given in the table. The data indicate that: 1. Barban ¼ lb/A applied at the 1½-2 leaf stage of wild oats reduced the yield of wild oats by 70%, basis all plots; while ½ lb/A applied at this time gave a reduction of 76% and 1 lb/A a reduction of 86%. 2. Wild oat control was more effective by the early application of barban, viz., ¼ lb/A applied at the 2½-3 leaf stage gave only 55% control, basis all plots. 3. Use of the hollow cone nozzle gave 10% (basis all plots) greater reduction of wild oats than the conventional fan nozzle. However, field observations suggested that application from the latter was more uniform. 4. Barban at ¼ lb/A applied to the 1½-2 leaf stage of wild oats increased the yield of wheat 112%, basis all plots. Yield boosts were about the same with the heavier rates but the grade of wheat was inferior. 5. The earlier applications of barban gave yield increases of wheat 80% above those from the later treatments, basis all plots (a 9.2 as compared to a 2.9 bu/A increase). 6. The use of the cone nozzle to apply barban gave increases in yield of wheat 28% above those obtained by use of the fan

Barban lb/A	Applied 1½-2 leaf stage of wild oats			Applied 2½-3 leaf stage of wild oats		
	Cone nozzle	Fan nozzle	Av.	Cone nozzle	Fan nozzle	Av.
	Yield wild oats, bu/A*					
0	24.7	20.7	22.7	28.2	24.9	26.6
¼	6.5	7.3	6.9	10.9	13.1	12.0
½	4.9	6.0	5.4	6.6	7.7	7.1
1	2.3	4.0	3.2	6.3	7.7	7.0
	Per cent reduction by barban					
¼	74	65	70	61	47	55
½	80	71	76	77	69	73
1	91	81	86	78	69	74
	Yield wheat, bu/A					
0	7.8	8.8	8.3	9.9	9.8	9.8
¼	17.1	18.1	17.6	15.4	12.2	13.8
½	16.4	17.3	16.8	16.6	11.9	14.3
1	19.3	16.5	17.9	10.6	9.3	10.0
	Per cent increased by barban					
¼	118	107	112	56	25	41
½	109	98	103	68	22	45
1	147	89	116	8	—5	1

* Cleaned from grain plus shattered.

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type, basis all plots (a 7.1 as compared to a 5.0 bu/A increase). 7. Barban at ¼ lb/A of delayed ripening 3 days, at ½ lb/A 12 days and 1 lb/A 14 days. Delay in maturity of wheat is an important consideration under Peace River conditions. (Canada Agriculture, Experimental Farm, Beaverlodge, Alberta.)

N-5996 (2,6-dichlorobenzonitrile) as a post-emergence chemical for wild oat control in spring wheat. Carder, A.C. This test was platted and conducted employing the same procedure as was used with barban (see preceding abstract) except that the rates of N-5996 were nil, 2, 3 and 4 lb/A. The same conditions, i.e., heavy and repeated germinations of wild oats, were met with as in the barban test. Frequent inspection of the N-5996 test plots revealed that no application induced any apparent suppression of wild oats; nor did any application seem to have an effect on the wheat. At harvest, all plots, including the non-treated checks, appeared alike so that yield data were not obtained. Non-test plots adjacent to the site on which this test was run yielded 24.6 bu/A of wild oats and 9.0 bu/A of wheat. (Canada Agriculture, Experimental Farm, Beaverlodge, Alberta.)

Effect of Niagara 5996 (2,6-dichlorobenzonitrile) as a foliage spray from cone and fan-type nozzles to wild oats, wheat and wild oats in mixture with wheat. Corns, Wm. G. Triplicate plots for each treatment were seeded with wild oats on May 11, and with wheat on May 16, so that each plot consisted of three parts, viz., Thatcher wheat, wild oats, and mixture of the two species. The herbicide was applied at 0, 2, 3, and 4 lb/A in 5 gal. water/A at 40 psi from cone and from fan-type nozzles. Treatments were made at 2 stages of growth, 2-2½ leaves and 3½-4 leaves, on June 9 and June 13. All of the treatments were almost completely ineffective. Only the pure stand of wild oats was harvested. Results as relative percentages are shown in the table for wild oats.

	Stage 1		Stage 2	
	Tillers	Dry wt. (Veg.)	Tillers	Dry wt.
Check	100	100	100	100
2 lb/A				
cone	104	99	90	93
fan	101	102	93	98
3 lb/A				
cone	116	110	86	92
fan	104	109	84	85
4 lb/A				
cone	100	97	71	89
fan	92	92	72	91

No differences attributable to nozzle type were evident. (Division of Crop Ecology, Dept. of Plant Science, Uni. of Alberta).

Effects of Avadex (2,3-dichloroallyl diisopropylthiolcarbamate) on some varieties of wheat, barley and rye, and on wild oats alone and in mixture with the grains. Corns, Wm. G. Triplicate plots for each treatment were sprayed with Avadex at 0, 1, and 2 lb/A in 10 gal/A water on May 25, double-disced the same day, and seeded on May 26. The grains noted in the table were seeded at 2 bu/A and one-half of each plot was cross-seeded with 2½ bu/A wild oats. Results for the crops as relative percentages of the data for weed-free checks are given in Table 1. Spring sown Kharkov winter wheat and Dakold winter rye were harvested for vegetative yield only. Table 2 contains data for wild oats from some of the mixtures at harvest time. Competitive stands of barley, and to a lesser extent Stewart durum wheat, produced relatively high yields from their weedy checks. Barley and durum wheat appeared least susceptible to the herbicide but in all cases there seemed to be a beneficial ultimate effect of the Avadex on yield of weedy grain. In several cases 2 lb/A was not greatly superior to 1 lb/A. The data for wild oats show varying extent of survival associated with crop competition and rate or herbicide applied.

Table 1

	Check		1 lb/A		2 lb/A	
	Pure	Weedy	Pure	Weedy	Pure	Weedy
Bread wheat						
Thatcher						
Tillers	100	71	85	75	98	86
Grain yield	100	54	84	56	100	73
Selkirk						
Tillers	100	78	109	105	107	104
Grain yield	100	56	103	82	109	83
Chinook						
Tillers	100	71	102	93	111	95
Grain yield	100	58	98	79	113	87
Kharkov						
Dry weight	100	41	101	47	94	78
Durum wheat						
Stewart						
Tillers	100	70	103	90	104	102
Grain yield	100	66	117	103	116	113
Golden Ball						
Tillers	100	66	109	90	113	105
Grain yield	100	56	103	86	103	91
Barley						
Montcalm						
Tillers	100	77	96	86	98	99
Grain yield	100	76	100	89	99	96
Parkland						
Tillers	100	89	96	86	97	92
Grain yield	100	74	103	80	102	87
Rye						
Dakold						
Dry weight	100	49	92	62	87	71

Table 2

Wild oats	in Thatcher		in Montcalm		in Stewart		Glumes in Montcalm	
	Tillers	Dry wt.	T.	D.W.	T.	D.W.	Total	Empty
Check	100%	100%	100%	100%	100%	100%	154	62
1 lb/A	78	88	37	52	31	26	110	44
2 lb/A	24	33	9	10	9	9	25	9

(Division of Crop Ecology, Dept. of Plant Science, Univ. of Alberta).

Comparison of barban (Carbyne) with two of its analogues for control of wild oats. Corns, Wm. G. Duplicate plots were seeded with wild oats at 2½ bu/A on May 19, and sprayed on June 9 when plants were in the 2 leaf stage. The following herbicides were applied at ¼ lb/A in 5 gal/A water at 30 psi from twin fan nozzles: Carbyne (4-chloro-2-butynyl *N*-(3-chlorophenyl) carbamate), S-3825 (4-thiocyanato-2-butynyl *N*-(3-chlorophenyl)carbamate), S-3776 (4-chloro-2-butynyl N-allyl-*N*-(3-chlorophenyl)carbamate). Dry weights and numbers of tillers of wild oats at harvest, Aug. 9, are shown as relative percentages in the table.

	Dry wt.	Tillers
Carbyne	100	100
S3825	240	317
S3776	337	459

Superiority of Carbyne is indicated. (Division of Crop Ecology, Dept. Plant Science, University of Alberta).

Effect of barban (Carbyne) applied from cone and fan type nozzles on the growth and yield of wheat, wild oats and a mixture of wild oats with wheat. Corns, Wm. G. Triplicate plots for each treatment were seeded on May 11 to wild oats at 2½ bu/A and on May 16 to Thatcher wheat at 2 bu/A, so that one-third of each plot was wild oats, one-third was wheat and the remainder was a mixture of the two. The treatments were 0, 4, 8, and 12 oz/A Carbyne applied at Stage 1 (2-2½ leaves), June 8, or at Stage 2 (3½-4 leaves), June 13. Split-plots were treated with 5 gal/A volume, at 40

lb pressure, from cone and from fan-type nozzles, for each rate of Carbyne at each stage. Treatments at 12 oz/A, and to a smaller extent at 8 oz/A, particularly at Stage 2, caused some stunting and delay in maturtiy of wheat. The grain yields and numbers of tillers shown in Table 1 are expressed as percentages of the untreated weed-free check.

Table 1

	Pure Thatcher				Thatcher from mixture with wild oats			
	Stage 1		Stage 2		Stage 1		Stage 2	
	Grain	Tillers	Grain	Tillers	Grain	Tillers	Grain	Tillers
Check	100	100	100	100	73	87	67	67
4 oz/A								
cone	115	108	95	102	109	101	69	66
fan	119	105	98	101	109	90	75	74
8 oz/A								
cone	114	117	93	96	123	109	74	79
fan	119	113	100	111	123	105	72	74
12 oz/A								
cone	104	115	87	119	114	101	85	102
fan	108	113	91	114	127	112	80	89

Apparently there was no adverse effect of the herbicide on grain yield of weed-free wheat and there was a definite wheat-yield improvement from treatment at Stage 1 of this crop grown with wild oats. Table 2 shows dry weights of wild oats plants and the numbers of tillers as percentages of the control and gives actual counts of pairs of occupied and empty glumes per square foot at harvest time of the wild oats from the mixture with wheat.

Table 2

	Stage 1				Stage 2			
	Dry wt.	Tillers	Glumes	Empty glumes	Dry wt.	Tillers	Glumes	Empty glumes
Check	100	100	165	140	100	100	226	175
4 oz/A								
cone	35	47	107	82	105	95	252	158
fan	54	66	96	59	105	108	187	143
8 oz/A								
cone	20	32	24	14	113	105	120	78
fan	15	24	47	26	123	111	108	66
12 oz/A								
cone	16	24	20	15	103	100	255	161
fan	15	24	26	14	90	91	209	125

The Carbyne reduced but did not prevent re-infestation by wild oats. There was no consistent difference between results from the fan and the cone type nozzles. (Division of Crop Ecology, Dept. of Plant Science, Univ. of Alberta).

Comparison of standard barban (Carbyne) with more concentrated formulation of the same herbicide. Corns, Wm. G. (a) Carbyne (4-chloro-2-butynyl *N*-(3-chlorophenyl)carbamate) (1 lb/U.S. gallon) was compared with (b) S-847-MN (the same herbicide at 2 lb/Imp gal) on a mixture of Thatcher wheat and wild oats in 3 replicates for each treatment. Treatments were 0, 4, and 8 oz/A in 7 gal/A water at 30 psi from twin fan nozzles. Spraying occurred on June 9 at 2-2½ leaf stage of wild oats and 2½-3 leaf stage of wheat. The tabulation shows final results as percentage of the check for the weedy mixture.

	Wild oats		Wheat	
	Tillers	Dry wt.	Tillers	Dry wt.
Check (mixture)	100	100	100	100
4 oz/A (a)	38	34	124	141
(b)	33	27	115	126
8 oz/A (a)	6	5	124	150
(b)	13	11	126	146
Check (Thatcher only)	—	—	133	131

Slight superiority of the standard formulation is indicated (Division of Crop Ecology, Dept. of Plant Science, Univ. of Alberta).

Comparison of cone, fan, and twin-fan nozzles for foliage application of barban (Carbyne) for control of wild oats in wheat. Corns, Wm. G. Wild oats and Thatcher wheat seeded at 2½ and 2 bu/A respectively, on May 19, were sprayed on June 9 when the oats had 2 leaves and wheat 2-3 leaves, with 0, and ¼ lb/A Carbyne in 7 gal/A solvent. Pressures were 30 psi for the fan and twin fan nozzles and 40 psi for the cone nozzle delivery. The table shows results as relative percentages for harvested material.

	Wild oats		Wheat	
	Dry wt	Tillers	Grain yield	Tillers
Check	100	100	100	100
Fan	32	41	157	128
Cone	34	42	165	131
Twin fan	22	33	164	139

It appears that there were no major differences attributable to nozzle type, but that there was marked improvement of grain yield as a result of the treatments with Carbyne. (Division of Crop Ecology, Dept. of Plant Science, Univ. of Alberta).

Control of wild oats with barban. Forsberg, D. E. On May 11th, 1960 wild oats were sown at 2½ bu/A on a area which was sown to Selkirk wheat on May 12th. Barban was applied at 0, ¼, ½, ¾ and 1 lb/A when the wild oats were in the 1½-2 leaf, 2½-3 leaf stages. At each of these dates the above rates were applied with a 73° hollow cone nozzle, an 80° fan nozzle and a 65° fan nozzle. The 80° nozzles were so arranged so that each fan overlapped to give double coverage of the area. All rates were applied in 5 gal/A of water. Conditions throughout the growing season were very dry. The types of nozzles used in this test did not have any effect on the degree of control obtained. The time of application was of utmost importance. Applying the herbicide at the 1½ to 2 leaf of wild oats resulted in the highest degree of control. At this date ¼ lb gave as good control as the higher rates. However, as the application of the herbicide was delayed it became evident that higher rates are required for any degree of control. At this early date of application there appeared to be some delayed maturity in the crop and yield reductions at the ¾ and 1 lb. rate. (Contribution from Experimental Farm, Research Branch, Scott, Saskatchewan.)

Experiments on the control of wild oats in flax with 2,3-dichloroallyl diisopropylthiolcarbamate (Avadex). Forsberg, D. E. Trial I—On May 9th, 1960 Avadex was sprayed on summerfallow at 1, 1.5, 2, and 2.5 lb/A in 5 and 10 gal/A of water on clay soil heavily infested with wild oats. Directly after spraying the herbicide was incorporated by a double disc harrow. The area was then sown to Marine flax. Trial II—On May 10th, 1960 stubble land heavily infested with wild oats was sprayed with Avadex at 1, 1.5, 2 and 2.5 lb/A in 5 and 10 gal/A of water on a clay soil. Directly after spraying one portion of the test was incorporated by a single operation of a double disc harrow while the remaining area received two incorporations with the same implement. Marine flax was then sown on the area after incorporation. Trash samples taken at the time resulted in 2,950 lb/A. Trial II—The wild oat population on the untreated plots averaged 290 plants/sq. yd. Avadex at 1 lb/A reduced the number of wild oats by 83 percent while at the 2½ lb it reduced them by 92 percent. Flax appeared very tolerant to the herbicide and yields at the 2.5 lb rate were 2.5 times greater that the check plot. Although slight differences were observed from the volumes of water used, the pattern was not consistent and consequently were not significant. Trial II-The results from the stubble trial were very similar to those obtained on the summerfallow. The use of a double incorporation did not improve the wild oat control when compared to a single incorporation. (Contribution from Experimental Station, Research Branch, Scott, Saskatchewan.)

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Control of wild oats in wheat with 2,3-dichloroallyl diisopropylthiolcarbamate (Avadex). Forsberg, D. E. On May 9th, 1960 Avadex was sprayed at 1, 1.5, 2, and 2.5 lb/A on summerfallow on a clay soil heavily infested with wild oats. Directly after spraying the herbicide was incorporated with a single operation of a double disc harrow. The area was then sown to Selkirk wheat. All rates of application reduced the stand of wheat by approximately 55 percent. In the check plots there were 179 wild oat plants/sq yd. Avadex at 1 lb reduced the population by 83 percent while at 2.5 lb the reduction was 88 percent. Slight yield increases over the check were obtained with 1, 1.5 and 2 lb/A. The 2.5 lb rate was equal to the check in yield. Volumes of water used did not affect the control in any measurable degree. (Contribution from Experimental Farm, Research Branch, Scott, Saskatchewan.)

Experiments for the control of wild oats in barley with 2,3-dichloroallyl diisopropylthiolcarbamate (Avadex). Forsberg, D. E. Trial I—On May 9th, 1960 Avadex at 1, 1.5, 2 and 2.5 lb/A in 5 and 10 gal/A water was sprayed on summerfallow on a clay soil heavily infested with wild oats. Directly after spraying the herbicide was incorporated with a single operation of a double disc harrow. The area was then sown to Parkland barley. Trial II—On May 10th, 1960 stubble land heavily infested with wild oats was sprayed with Avadex at 1, 1.5, 2 and 2.5 lb/A in 5 and 10 gal/A of water on a clay soil. Directly after spraying one portion of the test was single incorporated with a double disc harrow and the remaining area was double incorporated with the same implement. Parkland barley was then sown on the area after incorporation. Trash samples taken on the area resulted in 2,950 lb/A. Trial I—All treatments in the test had approximately a 50 percent reduction on the stand of barley resulting in yields which were equal to the check plot. In the check plot there were 109 wild oat plants/sq yd. Avadex at 1 lb/A resulted in a 81 percent reduction in wild oats while at 2.5 lb the reduction was 94%. The volume of water used did not affect the control obtained. Trial II—Stands of barley were reduced by approximately 45 percent with all treatments and methods of incorporation. Wild oat control was similar to that obtained on the summerfallow test. Yields of barley with all treatments were higher than the check plots. Methods of incorporation and volumes of water had no measurable effect on the control. (Contribution from Experiment Farm, Research Branch, Scott, Saskatchewan.)

Incorporation methods for pre-planting applications of 2,3-dichloroallyl diisopropylthiolcarbamate (Avadex). Friesen, H. A. Seven methods of incorporating Avadex into the surface soil were laid down, in a split-plot design, on stubble land carrying a moderately heavy infestation of wild oats, 80 to 100 plants/ sq yd. One-half of each treatment plot was sprayed with Avadex at 2 lb/A in 10 gpa of water. The stubble on the plot area had been one-way disced in the fall of 1959. The outstanding incorporation method was the use of two shallow (2-3 inches) strokes with the discer (one-way disc) followed by harrowing directly after spraying. This treatment reduced the wild oats by 86 percent and increased the yield of barley by over 15 percent. A single stroke with the discer gave only 65 percent kill of wild oats plants, while a stroke with the discer then deferring for 10 days before spraying and using the discer again resulted in a 72 percent kill of wild oats. Incorporation with the rototiller at 2, 4 and 8 days after spraying the Avadex gave 71, 72 and 61 percent kills of wild oats plants, respectively. The poorest kill of plants, 50 percent, resulted from the use of the harrow alone. All treatments increased the yield of barley by approximately 15 percent, except on the rototilled plots where the increase was 25-30 percent. However, these plots were seeded 8 days later than the others. (Contributed by the Experimental Farm, Lacombe, Alberta).

Selective control of wild oats with 2,3-dichloroallyl diisopropylthiolcarbamate (Avadex) in wheat and barley sown on summerfallow. Friesen, H. A. Wild oats were seeded with a double-disc plot seeder on summerfallow on May 10, 1960. Three days later, Avadex was sprayed at rates of nil, 1.0, 1.5, 2.0 and 2.5 lb/A in 5 and 10 gpa of water. All plots were one-way disced once directly after spraying and seeded to Parkland barley and Selkirk wheat with a press drill. The reduction in numbers of wild oats plants by Avadex treatments applied in 5 gpa of water was quite variable and less than expected in both the wheat and barley plots. The 2.5 lb/A dosage reduced the wild oats numbers by 75 percent in both crops while the other treatments resulted in about 50 percent reduction. Where the Avadex was applied in 10 gpa the reductions in the wheat were approximately 50, 70, 70 and 80 percent for 1.0, 1.5, 2.0 and 2.5 lb/A, respectively. In the barley plots the reductions were slightly higher, especially at 2.0 lb/A, which here equalled the 2.5 lb/A treatment. The numbers of wheat plants were reduced as a result of all treatments. The reductions ranged from 10 to 40 percent with increasing rates and were greatest where the 10 gpa spray volume was used. While none of the treatments reduced the yield of wheat, sizeable increases as the result of the wild oats control were realized following the use of Avadex at 1.0, 1.5 and 2.0 lb/A in 5 gpa of water and 1.0 and 1.5 lb/A in 10 gpa of water. The barley showed slightly more tolerance, particularly to the use of the herbicide in the 10 gpa spray volume. Again, no treatment reduced the yield but due to the light infestation of wild oats, increases due to their control were only in the range of 3 to 6 bu/A. The failure to achieve greater reductions in numbers of wild oats in this trial may be be due to the loose seedbed and thence excessively deep seeding of both the wild oats and crop. Wild oats plants which survived the treatments developed normally. (Contributed by the Experimental Farm, Lacombe, Alberta.)

Selective control of wild oats in barley and wheat on stubble land with 2,3-dichloroallyl diisopropylthiolcarbamate (Avadex). Friesen, H. A. Avadex at nil, 1.0, 1.5, 2.0 and 2.5 lb/A was applied in 5 and 10 gpa of water. Single and double one-way discing directly after spraying were used with each treatment. The plots were seeded to Parkland barley and Selkirk wheat the day following treatment. The plot area had been continuously cropped to grain since 1955 and carried an extremely heavy infestation of wild oats seeds in the soil. The plot area had been disced in the fall of 1959. Results; The untreated barley plots had 600 to 800 wild oats plants/sq yd. The greatest reduction in numbers of wild oats plants, some 90 percent, resulted from 2.5 lb/A of Avadex combined with double one-way discing. The 1.5 and 2.0 lb/A rates reduced the plant numbers by 70-85 percent, the greater reduction occurring at the higher rate with double incorporation. The 10 gpa spray volume gave slightly but consistently better wild oat control at either dosage than the 5 gpa volume, but its effectiveness was decidedly less than that of double incorporation. The 1.0 lb/A rate resulted in less than 70 percent kill of wild oats plants regardless of incorporation method or spray volume. Barley yields were increased by 25 to 100 percent as a result of the treatments, the greater yield increases corresponding generally with the better wild oats control. Although 2.5 lb/A reduced the number of barley plants by some 30 percent the crop yields on these plots far outyielded the untreated plots due to the extremely heavy infestation of wild oats. In the wheat plots the control of wild oats followed a pattern similar to the barley plots but the weed infestation was heavier, the checks averaging over 1000 plants/sq yd. All treatments, except 1 lb/A, when combined with double incorporation reduced the number of wheat plants from 20 to 40 percent. In spite of this, the wild oats control on all treatments was sufficient to result in large increases in the yield of wheat. In the untreated plots the yield of wheat was less than 4 bu/A due to the severe competition. (Contributed by the Experimental Farm, Lacombe, Alberta.)

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Effect of pre-planting treatments on wild oats in wheat. Molberg, E. S. and Banting, J. D. 2,3-dichloroallyl diisopropylthiolcarbamate (Avadex) was applied as a pre-planting treatment for the control of wild oats in Selkirk wheat on summerfallow and stubble land. Rates of 1, 1.5, 2 and 2.5 lb/A were applied in spray volumes of 5 and 10 gpa and incorporated into the soil with one discer operation. The wheat was sown the day after treatment with a double disc drill followed by a packer. On summerfallow the check plots contained 97 plants/sq yd and yielded 28 bu/A of wheat. The treatments reduced the number of wild oat plants by 69 to 96% and the number of wheat plants by 63 to 97%. The reduction in yield of summerfallow treatments varied from 3 to 25 bu/A. On stubble the check plots contained 103 wild oats plants/sq yd and yielded 23 bu/A of wheat. The treatment reduced the wild oats by 64 to 93% and the wheat plants by 47 to 96%. The treatment which gave the least damage to wheat (47% stand reduction) was 1 lb/A in 10 gpa, which provided 79% wild oat control and a yield increase of 6 bu/A. (Contributed by the Research Branch, Experimental Farm, Regina Saskatchewan.)

Effect of pre-planting treatment on wild oats in barley. Molberg, E. S. and Banting, J. D. 2,3-dichloroallyl diisopropylthiolcarbamate (Avadex) was applied as a pre-planting treatment for the control of wild oats in Parkland barley on summerfallow and stubble land. Rates of 1, 1.5, 2 and 2.5 lb/A were applied in spray volumes of 5 and 10 gpa, and incorporated into the soil with a single operation with a discer. The barley was sown immediately after treatment with a double disc drill followed by a packer. On fallow the wild oat control, based on number of plants at harvest, varied from 78.8 to 97.5%. The stand of barley was reduced by 59.7 to 84.2%, but the remaining plants stooled out and grew vigorously with adequate soil moisture and without competition from wild oats or other weeds, so that there was little reduction in dry weights of the crop and the yields ranged from a decrease of 2.2 to an increase of 6.2 bu/A. The optimum treatment considering both wild oat control and yields was 1.5 lb/A in 10 gpa of spray. This resulted in 93.4% wild oat control and a yield increase of 6.2 bu/A. On stubble wild oat control ranged from 80.2 to 98.9% for all treatments except 1 and 1.5 lb/A in 10 gpa, which gave 13.3 and 14.0% control respectively. With this exception there was no marked difference in wild oat control between the two volumes of spray solution. Barley stand reductions were lower on fallow, ranging from 2.0 to 63.5%, and yields ranged from a decrease of 1.7 to an increase of 8.8 bu/A compared to the untreated checks. The optimum treatment on stubble was 2 lb/A in 10 gpa of spray. This gave 99% wild oat control and a yield increase of 8.8 bu/A. (Contributed by Research Branch, Experimental Farm, Regina, Saskatchewan.)

The effect of different amounts of straw cover on the number of wild oats in the crop. McCurdy, E. V. Replicated 1/30 acre plots, arranged in a two-year cropping system, were sown to wheat in 1960. All the straw from the combine had been spread on these plots and an additional ton per acre of straw had been added to some. Half were disked in the fall and the others left unworked. Square yard wild oat plant counts taken in the crop in 1960 averaged 5 for the unworked plots with normal stubble, and 5.9 where the additional straw had been added; the disked plots averaged 1.6 plants each. This indicated that under the conditions existing this year the additional straw cover had little effect on the germination of wild oats. All straw was burned off another group of plots in this same project, one half the plots were disked and the other left unworked. No wild oats were found in the square yard samples in the unworked plots and only 0.1 in the worked. (Contributed by the Experimental Farm, Indian Head, Saskatchewan.)

Post emergence control of wild oats with barban (Carbyne). McCurdy, E. V. Barban was applied with cone and fan nozzles, at 0, ¼, ½ and 1 lb/A at the 2-, 3-, and 4-leaf stages of wild oats growing in Selkirk wheat. Ignoring nozzles and dates, the average wheat yield for the untreated plots was 27.5 bu/A; where ¼ lb/A was used, 29.1 bu/A; ½ lb, 30.2, and 1 lb, 29.8. This indicates that a decrease in yield did not occur even at 1 lb/A, although a slight effect on maturity and height had been noted throughout the season. Wild oats were effectively controlled at the 2-leaf stage at the three rates with both nozzles but control was not satisfactory at the 3-leaf stage with the fan nozzle at ¼ lb/A. Wild oats were not controlled at the 4-leaf stage at any rate. The actual square yard plant counts at 0, ¼, ½ and 1 lb/A respectively were as follows: at the first date with the cone nozzle, 18, 5, 5, and 1; with the fan nozzle, 23, 7, 5, and 2; at the 2nd date with the cone nozzle, 37, 5, 3, 3,; the fan nozzle, 22, 17, 5 and 3; at the 3rd date with the cone nozzle, 31, 18, 18 and 16; the fan nozzle, 17, 28, 18 and 18. (Contributed by the Experimental Farm, Indian Head, Saskatchewan.)

Dates of spring and fall tillage for wild oat control. McCurdy, E.V. The effect of different dates of tillage on the number of wild oats in the crop has been studied in a group of plots sown continously to barley for the past five years. Because of heavy precipitation in the fall of 1959, all fall work could not be carried out on schedule. The cumulative results indicate fall discing in late September or early October has been more effective in keeping the number of wild oats from increasing than when tillage was carried out at the other dates in the project. The approximate date of tillage, with the 1960 wild oat square yard count listed in brackets, is as follows: September 20, (1.6 wild oats per sq yd); October 5, (0.7); October 20, (3); October 20 and early spring, (4); early spring, (6); and no cultivation except just before seeding, (14). This same pattern has occurred most years. (Contributed by the Experimental Farm, Indian Head, Saskatchewan.)

Preplanting herbicides for wild oat control. McCurdy, E. V. 2,3-Dichloroallyl diisopropylthiolcarbamate (Avadex) was applied at rates of 0, 1, 1.5, 2.0 and 2.5 lb/A to plots that had been in summerfallow in 1959. The herbicide was applied on May 27 and the field was disced and harrowed later on the same day. Wind gave some trouble and this may have had a slight effect on the even distribution of the herbicide. The soil was very moist and not in ideal condition for incorporation. A drill width of Marine flax, Parkland barley and Selkirk wheat was sown across each plot and a fourth area was left with no crop competition. The average count of wild oat plants at harvest time for the whole 8 x 10 foot plot where there was no crop competition, was 83 for no treatment, 27 where 1 lb/A of Avadex had been applied; 12 for 1.5 lb/A; 8 for 20 lb/A; and 6 for 2.5/A. Where flax was sown the plant counts were very similar; 79, check; 13, 1 lb/A; 8, 1.5 lb/A; 6, 2 lb/A; and 4, 2.5 lb/A. Very satisfactory control occurred at 1.5 lb/A and higher. At the rates used in this test, Avadex had little effect on the yield of barley but caused a slight decrease in the yield of wheat, particularly at 2.5 lb/A.

2,6-Dichlorobenzonitrile (Niagara 5996) was applied at the same time as a pre-emergence herbicide at 2 and 4 lb/A. Although wild oats were controlled, the three crops were also severely injured. (Contributed by the Experimental Farm, Indian Head, Saskatchewan.)

Residual effect of Avadex and EPTC applied in 1959 on wild oats and grain crops in 1960. Friesen, H. A. Avadex, 2,3-dichloroallyl diisopropylthiolcarbamate, was applied in both liquid and granular forms at nil, 2, 3, 4, and 6 lb/A and EPTC at 2 and 4 lb/A in the spring of 1959. The herbicides were incorporated by one-way discing directly after spraying and the entire area was seeded to Olli barley. The results are reported in the Reasearch Report of the National Weed Committee (Western Canada) pp 45-46. Trial III. In 1960, bands of wheat, oats and barley were seeded across the strips treated in 1959. No further Avadex was applied in 1960. The infestation of wild oats on the strips not sprayed in

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1959 was some 10 plants/sq yd. In 1960 it had increased to about 100 plants in the wheat and oats and 35 plants in the barley. Avadex (liquid form) at 3, 4, and 6 lb/A reduced the numbers of wild oats plants by over 90%. At the 2 lb/A rate the reduction was about 70%. There were not sufficient wild oats in the Avadex granular and EPTC strips to permit a control rating. The reduction in wild oats at 2 lb/A increased the yield of wheat by more than 50%, the yield of barley by 30% and the yield of oats by 20%. The lower increases in the barley yield appeared to be due to the lighter wild oats infestation. The oat stands were greatly reduced by the heavier Avadex treatments and 6 lb/A significantly lowered the yield. While Avadex in excess of 2 lb/A reduced the stand of barley plants, this was not sufficient to reduce the yield of crop. The number of wheat plants was reduced 14% by 6 lb/A but extra tillering resulted in 45% increase in yield. EPTC resulted in some reduction of the yield of oats and barley at both 2 and 4 lb/A. (Contributed by the Experimental Farm, Lacombe, Alberta.)

Selective control of wild oats in Thatcher wheat and Vantage barley with barban (Carbyne). Friesen, H. A. Part. I. Barban at nil, ¼, ½ and 1 lb/A in 5 gpa of water was sprayed on wild oats in Thatcher wheat at the 1½-2 leaf, 2½-3 leaf, and 3½-4 leaf stages of the weed. Hollow cone (X-4) and flat fan (650067) nozzles were used. Each was operated 45 psi pressure. Dry, cool, windy weather tended toward very slow weed and crop development in June, and very hot, dry weather in July resulted in further suppression of growth. The wild oats infestation was heavy, 100 plants/sq yd, on only one replicate, but average infestation for the test was only 40 plants/sq yd. Results: Based on kill of wild oats and yield of wheat ½ lb/A of barban was the outstanding treatment. Reduction in numbers of wild oats plants reached 60% at the 1½-2 leaf stage but it was not appreciably less at the other two growth stages. Yield of wheat was increased by 5 to 20%. On the replicate having the heavy infestation the yield increases ranged to 50%. Barban at 1 lb/A resulted in about 20% greater kill of wild oats but delayed crop maturity at all stages and thinned the stand of wheat at the 1½-2 leaf stage. At the two later stages, the injury was less severe and the wheat yields equalled those on ½ lb/A treated plots. Barban at ¼ lb/A resulted in 35% kill of wild oats plants when applied with cone nozzles at the 1½-2 leaf stage. This dosage at the other two stages or with the fan nozzle at all stages was less effective. Small increases, about 5%, in the yield of wheat were realized as a result of the wild oats control. On the one replicate where the infestation was heavy the ¼ lb/A treatment consistently increased the yield of wheat but much less than at ½ lb/A. Part II. The above treatments were laid down on plots seeded to Vantage barley. The infestation of wild oats was negligible, less than 3 plants per sq yd. None of the treatments significantly affected the number of barley plants nor the yield of the crop. (Contributed by the Experimental Farm, Lacombe, Alberta).

Post-emergence treatments for wild oat control in wheat. Molberg, E. S. and Banting, J. D. Barban (Carbyne) was applied to Selkirk wheat at rates of .25, .50, .75 and 1 lb/A when the wild oats were in the 1.5 to 2-, 2.5 to 3-, and 3.5 to 4-leaf stages of growth. The tests were carried out on summerfallow land in which wild oats were sown two days before the crop. The herbicide was applied in 5 gpa of spray solution with cone- and fan-type nozzles. At harvest time the check plots contained an average of 134 wild oat plants/sq yd and yielded 29.5 bu/A of wheat. Significant reduction in wild oat culms resulted at the 1st stage from .25 lb/A rate with the cone nozzle and .50 lb/A with the fan nozzle. At the 2nd stage 1 lb/A reduced the infestation by 57 to 66% and increased the yields by 13 bu/A. Applications with the fan nozzle appeared to be more effective. The most satisfactory wild oat control and the highest yield was obtained with .75 lb/A at the 1st stage with the fan nozzle. This gave 85% control and a yield increase of 14 bu/A. The .50 and .25 lb rates gave 83 and 49% control and increases of 11 and 7 bu/A respectively. None of the treatments gave satisfactory control at the 3rd stage of growth. (Continued by the Research Branch, Experimental Farm, Regina, Saskatchewan.)

Post-emergence treatments for wild oat control in barley. Molberg, E. S. and Banting, J. D. Barban (Carbyne) was applied to Parkland barley at rates of .25, .50, .75 and 1 lb/A when the wild oats were in the 1.5 to 2-, 2.5 to 3-, and 3.5 to 4-leaf stages of growth. The tests were carretd out on summerfallow land in which wild oats were sown two days before the crop. The herbicide was applied in 5 gpa of spray solution with cone- and fan-type nozzles. At harvest time the check plots contained an average of 97.5 wild oat plants/sq yd and yielded 43.6 bu/A of barley. Treatment with the fan nozzle gave greater wild oat control than the one with the cone nozzle. Early spraying was most effective. At the 1.5 to 2-leaf stage .50 lb/A applied with fan and cone nozzles reduced the wild oat stand by 85 and 40% and increased yield by 17 and 8 bu/A respectively. There was no advantage in increasing the rate above .50 lb/A at the early stage. At the 2nd growth stage the best wild oat control (65%) was obtained with .75 lb/A applied with the fan nozzle. This resulted in a yield increase of 10 bu/A. The best control obtained with the cone nozzle at this stage was 34% at 1 lb/A but this decreased the barley yield by 8.4 bu. Wild oat control at the 3rd growth stage was unsatisfactory at the above rates. (Contributed by the Research Branch Experimental Farm, Regina, Saskatchewan.)

Effect of 2,3-dichloroallyl diisopropylthiolcarbamate (Avadex) on wild oats in three crops, 1960. Skoglund, N. A., Selleck, G. W., and Coupland, R. T. Avadex was applied to duplicated plots (15 x 200 ft) at an initial rate of 4.3 lb/A in 13 gal/A water with a logarithmic sprayer (fan nozzles) on loam soil near Spalding, Sask., on May 16-17. Incorporation was by double discing, followed by immediate seeding of crop. The percentage control of wild oats obtained at maturity was as follows:

	Percent control of wild oats in		
Rate, lb/A	Barley (Husky)	Wheat (Thatcher)	Rape (Polish)
4.3	65	80	95
3.3	83	—	—
2.2	59	75	85
1.7	—	—	67
1.3	—	80	77
1.1	65	60	70
0.7	50	—	—

Control was rated as reduction in number of panicles per unit area. The number of heads of wheat was reduced by 30% at 4.3 lb/A, 10% at 2.2 lb, and nil at 1.7 lb. Some delay in maturity resulted where number of heads was reduced. The high rates caused a slight delay in maturity of barley, but none in rape. (Contribution No. 313 from the Department of Plant Ecology, Univ. of Saskatchewan, Saskatoon, in cooperation with the Monsanto Chemical Co.)

The effect of barban (Carbyne) on wild oats in wheat, 1960. Skoglund, N. A. and R. T. Coupland. Duplicate plots (15 x 200 ft.) were treated at various stages with barban at an initial rate of 2 lb/A in 13 gal of water using a logarithmic sprayer (fan nozzles) on silty clay loam near Saskatoon, Sask. The wheat (Thatcher) had begun to emerge on June 1. The results were as follows:

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Barban applied lb/A	Date of treatment: June 6	June 10	June 13	June 18	June 8
	No. of leaves and height, inches, wild oats				
	1¼-1¾ 1-3	1¾-2 2-3	2-2¼ 3-4	3-4 4-5	3 (1-5) 4-5
	No. of leaves and height, inches, Thatcher wheat				
	2 2-2½	2½ 2½-3½	3 3-5	4 7-8	4-5 7-8
	Wild oats, percent control				
2.0	60	90	100	100	60
1.2	—	—	80	—	—
1.1	42	—	—	—	—
1.0	—	40*	50	90	60
0.7	0	75	—	—	—
0.6	—	0	50	40	—
0.5	—	—	—	90*	80*
0.2	—	—	50	80*	50
	Wheat, percent damage				
2.0	0	35	65	80	65
1.3	—	0	—	—	—
1.0	—	—	0	—	20
0.8	—	—	—	0	0
	Wild buckwheat, percent control				
2.0	10	10	10	50	—
1.0	0	0	—	50	—
0.6	—	—	—	25	—

* Effect doubtful because of poor stand.

The control (and damage) to the grasses is based on counts of inflorescences per unit area, at maturity. The damage to *Polygonum* is based on reduction in productivity of foliage. Where the number of heads of wheat was reduced by treatment, the heads were judged also to be somewhat reduced in size and delay in maturity of the crop of 4 to 6 days resulted, but no plants were killed. There was no apparent reduction in size of wild oat inflorescences due to treatment. Plants of wild oats were killed by treatment and no regrowth was observed. The results indicate that effective control of wild oats by this herbicide can be obtained at 0.5 lb/A and less at the proper stage of growth. (Contribution No. 309 from the Department of Plant Ecology, Univ. of Saskatchewan, Saskatoon, with financial assistance from the Sask. Agric. Res. Foundation.)

Effect of post-emergence herbicides on wild oats in Argentine rape, Skoglund, N. A. and Coupland, R. T. Duplicate plots (15 x 200 ft.) were treated at three stages with a logarithmic sprayer equipped with fan nozzles using barban (Carbyne) at an initial rate of 2 lb/A and 2,6-dichlorobenzonitrile (N5996) at 4 lb/A on silty clay loam soil near Saskatoon, Sask. The control of wild oats is based on the reduction in number of inflorescences, while damage to rape is based on decrease in volume of growth. The plots were sown May 29, and emergence began June 8. The results were as follows:

Herbicide applied lb/A	Rape: Treated June 13	18	23	Wild oats: 13	18	23
	No. of leaves and height, inches					
	2 1	2 1	4 1½-2	2¼-3 3-4	2¼-5 3-5	2½-5 4-6
	N5996, percent damage or control					
4.0	10	50	60	63	45	10
3.5	—	—	0	—	—	0
3.2	—	—	0	0	—	—
3.0	0	0	—	—	—	—
2.8	—	—	—	—	0	—
	Barban, percent damage or control					
2.0	65	35	100	75	75*	75
1.5	0	0	—	65	75	12
1.0	0	0	100	20	50*	—
0.4	0	0	65	—	—	—

* Effect doubtful because of poor stand.

The effect on rape was to kill some plants and to dwarf the rest . The third treatment with Carbyne prevented development of inflorescences. Otherwise no delay in maturity was observed. Damage to rape by Carbyne was very severe at 15 days after emergence, and was least 10 days after emergence. (Contribution No. 311 from the Department of Plant Ecology, Univ. of Saskatchewan, Saskatoon, with financial assistance from the Sask. Agric. Res. Foundation.)

Effect of two post-emergence herbicides on wild oats in barley and flax. Skoglund, N. A. and Coupland, R. T. 2,6-dichlorobenzonitrile (N5996) at an initial rate of 4 lb/A and barban (Carbyne) at 2 lb/A in 13 gal/A of water were applied on June 18 with a logarithmic sprayer (fan nozzles) to duplicate plots (15 x 200 ft.) in Hannchen barley, sown May 29, emerging June 5, and Redwing flax, sown June 5, emerging June 11, on light loam near Borden, Sask. The results were as follows:

Herbicide applied lb/A	Barley	Flax
	No. leaves and height of crop	
	3 4½-5½	2 1
	No. leaves and height of wild oats	
	1½-2 2-3	1-1½ 1-3
Barban	Wild oats, per cent control	
2.0	45	45
1.4	40	—
1.0	35	10
0.9	—	0
N5996		
4	10	10
Barban	Crop, per cent damage	
2.0	30	95
1.0	0	0
N5996		
4.0	0	90
3.8	—	0

The control of wild oats and damage to barley is based on the reduction in number of inflorescences per unit area at maturity, while for flax reduction in mass of plant was estimated. The highest rate of barban delayed maturity of barley by 4 to 6 days. The poor control of wild oats obtained, as compared with other experiments, is presumably related to erratic germination of wild oats. At the time of application many had just emerged, and it is probable that a large number emerged after treatment. (Contribution No. 310 from the Department of Plant Ecology, Univ. of Saskatchewan, Saskatoon, with financial assistance from the Sask. Agric. Res. Foundation.)

Effect of post-emergence herbicides on wild oats using twin-jet nozzles, Skoglund, N. A. and Coupland, R. T. Barban (Carbyne) and 2,6-dichlorobenzonitrile (N5996) were applied at 2-day intervals at the respective initial rates of 0.4 and 4.0 lb/A in 10 gal/A of water to duplicated plots (15 x 200 ft.) using a logarithmic sprayer on a silty clay loam near Saskatoon, Sask. The results were as follows:

Herbicide applied lb/A	Per cent control wild oats, treated: May 28	May 30	June 1
	Wild oats, no. leaves and height, inches		
	1½-2 2-3	1¾-2¼ 3-3+	1¾-2½ 2½-3½
	Wheat, no. leaves and height, inches		
	3 2-3	3 2-3+	3½ 2½-3½
Carbyne			
0.40	50*	65	70
0.30	72	—	10
0.28	—	10	—
0.25	0	0	—
0.16	—	—	0
N5996			
4.0	62	50	—
3.0	55	0	—
2.5	0	—	—

* Effect doubtful because of poor stand.

Control was rated on the basis of the reduction in number of inflorescences per unit area at maturity.

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Wheat (Lake) and *Polygonum convolvulus* were not noticeably damaged by any treatment. The results of this test should be considered with regard to the possibility that the use of twin-jet nozzles has increased the effectiveness of Carbyne. (Contribution No. 312 from the Department of Plant Ecology, Univ. of Saskatchewan, Saskatoon, with financial assistance from the Sask. Agric. Res. Foundation.)

Quality effect on hard red spring wheat, durum and barley by post-emergence application of barban (Carbyne) applied for wild oats control. Zinter, C. C. and Amstrup, C. R. Carbyne at ½ lb/A active ingredient during the 2-leaf stage of wild oats applied by farmers with assistance of herbicide field men. Paired grain samples collected at random from combines at harvest time. Hard red spring wheat, 52 pairs of samples: Grade was improved by barban treatment one grade 10 times, 2 grades once, and 3 grades once. Grade was reduced one grade 10 times and 2 grades 5 times. Grade was unchanged 24 times. Treatment increased test weight 21 times, decreased test weight 27 times, and was the same 3 times. Average test weight of treated was 55.9 lb/bu; non-treated 56.0 lb/bu. Dockage was decreased by treatment 33 times, increased 13 times and the same 5 times. Durum, 19 pairs of samples: Grade was improved by barban treatment one grade 3 times, 2 grades twice and 3 grades once; grade was reduced 1 grade 5 times and unchanged 8 times. Treatment decreased dockage 13 times and increased dockage 6 times. Test weight was decreased 9 times, increased 6 times and the same 4 times; average test weight was: treated, 60.6 lb/bu; not treated, 60.3 lb/bu. Barley, 11 pairs of samples; Grade was improved by barban treatment 1 grade 3 times, 2 grades once, and 3 grades once; grade was reduced 1 grade twice and 4 times unchanged. Barban treatment increased test weight 7 times and decreased test weight 4 times. Average test weight: treated, 45.5 lb/bu, not treated, 44.8 lb/bu. Carbyne treatment reduced dockage 6 times, increased dockage 2 times, unchanged 3 times. Average barley plumpness was 40% for treated and 34% not treated. Average barley thin kernels were 11.4% for treated and 14.1 not treated. (Contribution of F. H. Peavey & Company, Minneapolis, Minnesota.)

WILD BUCKWHEAT

Comparison of 2-methoxy-3,5,6-trichlorobenzoic acid (Velsicol C) with 2,4-D for control of Tartary buckwheat in wheat. Corns, Wm. G. Thatcher wheat and Tartary buckwheat were planted in alternating rows in replicated flats of soil in the greenhouse and sprayed with the herbicides Velsicol C and butoxy ethanol ester of 2,4-D when the buckwheat had 2-3 leaves and the wheat was 10-12" tall, about two weeks after emergence. The table gives the relative percentages, three weeks after spraying.

Treatment lb/A	No. of buckwheat plants	Dry wt. of buckwheat	Dry wt. of wheat plants	Height of wheat
Check	100	100	100	100
Velsicol C				
½	8	3	117	95
1	3	1	130	109
2	1	0.5	114	93
2,4-D				
¾	1	1	99	84

The results are encouraging with respect to the herbicidal activity of Velsicol C and its tolerance by wheat. (Division of Crop Ecology, Dept. of Plant Science. Univ. of Alberta).

Herbicides for the control of wild buckwheat. Forsberg, D. E. Wild buckwheat, in a crop of Selkirk wheat, was treated as follows: 2,4-D butyl ester at 5, 8 and 16 oz/A; 2-methoxy-3,6-dichlorobenzoic acid (compound B) at 5, 7, 8, 11, 16 and 22 oz/A; 2-methoxy-3,5,6-trichlorobenzoic acid (compound C) at 5, 7, 8, 11, 16 and 22 oz/A; and Celatox (MCPA plus a 2,4,5-T isomeric mixture) at 8, 11 and 16 oz/A. The herbicides were applied when buckwheat was in the 3-3½ leaf and wheat in the 2 leaf stage, and again when buckwheat was in the 2-6 leaf stage and wheat in the 5 leaf. Applications were made in 7 gal/A of water. 100 percent kill of wild buckwheat was obtained with all rates and dates of compound B. The 22 oz. rate at date 2 reduced the yield of wheat by ½ of the check yield. Compound C resulted in 95 to 100% control of buckwheat at the 8, 7, 11, 16 and 22 oz. rates and substantial yield increases over the check plot. Both of these hebicides resulted in some head deformities. The 2,4-D butyl ester retarded buckwheat growth at the higher rates but did not result in kill. Celatox had no effect on wild buckwheat. (Contribution from Experimental Farm, Research Branch, Scott, Saskatchewan.)

Control of wild buckwheat with barban. Forsberg, D. E. Selkirk wheat, heavily infested with wild buckwheat, was top sprayed with barban at 0, ¼, ½, ¾ and 1 lb/A when the buckwheat was in the 2 and 4-leaf stage. In applying the herbicide a 73° hollow cone nozzle, a 65° fan nozzle and an 80° fan nozzle were used. The 80° nozzles were so arranged that each fan overlapped to give double coverage over the area. Complete kills of wild buckwheat were recorded with all rates of barban when applied at the two-leaf stage. At this stage the type of nozzle used did not affect the degree of control obtained. However, when spraying was done at the 4-leaf stage the hollow cone resulted in 12 percent less control than the 65° fan and a 16 percent less control than the 80° fan. At this stage, within nozzles, there was no difference between rates in the control of wild buckwheat. At the 2-leaf stage wheat yield increases were noted with all rates used, while at the 4-leaf stage all rates resulted in a yield reduction. (Contribution from Experimental Farm, Research Branch, Scott, Saskatchewan.)

Control of wild buckwheat with butyric compounds. Forsberg, D. E. On June 14th plots of Chinook wheat heavily infested with wild buckwheat were top-sprayed with 4-(MCPB) and 4-(2,4-DB) when in the 2-leaf stage and when wild buckwheat was in the 1 to 8-leaf stage. The butyrics were applied at 16 and 24 oz/A each in 5, 10, 20 and 30 gal/A of water. The 4-(MCPB) at the rates used and in varying volumes of water had no effect on the wild buckwheat. The 4-(2,4-DB) gave approximately 50% kill of wild buckwheat at both 16 and 24 oz/A. The initial effect on wild buckwheat was greater with the 5 and 10 gal/A of water than with the higher volumes. Remaining wild buckwheat plants in the 4-(2,4-DB) plots were producing seed by harvest time but were stunted sufficiently not to interfere with harvesting operations. 4-(2,4-DB) at 24 oz resulted in 100% control of Russian thistle, but 4-(MCPB) had no effect on Russian thistle. (Contribution from Experimental Farm, Research Branch, Scott, Saskatchewan.)

Control of wild buckwheat with 2-methoxy-3,6-dichlorobenzoic acid. Forsberg, D. E. Selkirk wheat heavily infested with wild buckwheat was top sprayed with 2-methoxy-3,6-dichlorobenzoic acid when in the 6-8 leaf stage and when buckwheat was in the 10 leaf to early vining stage. Rates of 4, 8, 12, 16 and 24 oz/A, each in 5, 10 and 20 gal/A of water, were used. All rates used resulted in a decrease in yield of wheat. The 5 gal/A of water resulted in the lowest reduction in yields. At this stage on wild buckwheat the 4 and 8 oz resulted in a 90 and 95 percent kill of wild buckwheat. The higher rates gave 100 percent kill of the buckwheat but

XUM

reduced the yields of grain severely. (Contribution from Experimental Farm, Research Branch, Scott, Saskatchewan.)

OTHER ANNUAL WEEDS

Control of green foxtail with herbicides in a crop of flax. Forsberg, D. E. An area of wheat stubble uniformly infested with green foxtail, after being cultivated, was sprayed on May 31st with 2,3-dichloroallyl diisopropylthiolcarbamate, (Avadex) and amiben at 8, 16 and 32 oz/A in 7 gal/A of water. The Avadex plots were incorporated immediately and the area was sown to Marine flax. On July 6th, when flax was 4-6 inches high and green foxtail was in the 5-6 leaf stage, additional plots were top sprayed with 16, 32 and 64 oz/A (weights of 90% commercial formulation) of TCA and 4, 8, and 16 oz/A of dalapon in 7 gal/A water. Subplots in the test were sprayed with 2,4-D butyl ester and MCPA ester to control annual weeds. All rates of Avadex used in this test gave no control of green foxtail. From 90 to 100% kill of green foxtail was obtained with 16 and 32 oz/A of amiben. TCA at the rates used did not effect satisfactory control. Dalapon at 16 oz/A resulted in 90% kill, but the lower rates had a stunting effect rather than complete kill. Yields of flax were considerably higher with all rates of amiben than the weedy check and were equal to the weed-free check. Higher rates of TCA and dalapon had a depressing effect on yield particularly when used with this low volume of water. (Contribution from Experimental Farm, Research Branch, Scott, Saskatchewan.)

Control of wild bromegrasses with herbicides used pre-emergence or early post-emergence. Freeman, J. F. Cheat, hairy chess, and downy brome were each sowed broadcast at 25 lb/A September 19, 1959, on prepared Maury silt loam soil at Lexington. Soil was cultipacked before and after seeding. Seedings were in parallel strips crosswise of 6 x 23 ft plots to serve as sub-plots to herbicide treatments of a split-plot design with 4 replications. Because of dry weather after seeding, plots were irrigated October 2. Herbicides were applied pre-emergence October 5 and early post-emergence (seedlings 1.5-3 in. tall) October 17, in water sprays at 28 gpa. Plots were irrigated lightly after pre-emergence treatment. The number of plants in 10 sq ft in each sub-plot was determined in January 1960. Treatments and percentage reduction in stand (av of the 3 species), based on the untreated check which had 49 plants/sq ft, follow: Pre-emergence: CIPC 3, 4, and 5 lb/A, 91, 97, and 97% reduction respectively; dimethyl 2,3,5,6-tetrachloroterephthalate (Dacthal) 5, 7.5, and 10 lb/A, 6, 7, and 13%; early postemergence; CIPC 3, 4, and 5 lb/A 54, 63, and 82%; dimethylamine salt of 2,3,6-TBA, 41, 39, and 48%. In the same experiment foliage treatments in mid-April, 1960, with chess plants 4-6 in tall, the sodium salt of endothal 1, 2, and 4 lb/A, or 2,3,6-TBA 2, 4, and 6 lb/A, resulted in only slight reduction in dry weight of chess at maturity in comparison to that of the untreated check. (Agronomy Department, Kentucky Agr. Exp. Sta.)

Relative susceptibility of annual weeds to several herbicides. Skoglund, N. A. and Coupland, R. T. In a test of practicability of chemical fallow at Saskatoon, the stand of four annual weeds was sufficiently dense to permit an evaluation of the relative susceptibility of each to various herbicides. Treatment was with a logarithmic sprayer at an initial rate of 4 lb/A in 34 gal of water to 15 x 100 ft plots on July 18 to a mixed stand of weeds which had been tilled with a duckfoot cultivator on June 14 and subsequently grown to a height of 8 in. Some weeds were in early bud. Effect on weeds was estimated on July 25 on the basis of ratings (0= no effect, 7=satisfactory control. 10=100% control).

Herbicide and rate	*Portulaca oleracea*	*Amaranthus graecizans*	*Salsola pestifer*	*Amaranthus retroflexus*
4 lb/A				
G34162[1]	10	10	10	10
Prometone	10	10	5	9
Atrazine	10	10	10	10
2,4-D	9	7	3	6
CP1815[2]	4	2	4	3
2,3,6-TBA	1	1	3	2
2 lb/A				
G34162[1]	9	9	9	9.5
Prometone	4	7	2	5
Atrazine	7	9	0	7.5
2,4-D	7	1	2	1.5
CP1815[2]	2	1	3	2
2,3,6-TBA	0	0	1	1
1 lb/A				
G34162[1]	8	8.5	7	9
Prometone	1.5	4	1	1
Atrazine	4	8	0	7
2,4-D	5	0	1	1
CP1815[2]	1	0	1	1
2,3,6-TBA	0	0	0	0

[1] 2-ethylamino-4-isopropylamino-6-methylmercatpo-s-triazine
[2] Mixture of chlorinated benzoic and cresoxyacetic acids.

Simazine was included in the tests, but gave no control even at the highest rates. G34162 provided moderate control (rating = 5) of *Portulaca* and both species of *Amaranthus* at the lowest rate applied (1.25 oz/A). (Contribution No. 308 from the Dept. of Plant Ecology, Univ. of Saskatchewan, with financial assistance of the Sask. Agric. Res. Foundation).

Relative susceptibility of annual weeds to 4-(2,4-DB). Skoglund, N. A. and Coupland, R. T. An application of butyl ester of 4-(2,4-DB) at 1 lb/A in 34 gal. of water on July 9 in a second-year stand of alfalfa at Saskatoon resulted in the following degrees of control for the various annual weeds present:

Almost complete control
- *Salsola pestifer* (in bud, up to 14 in. high)
- *Chenopodium album* (bud, up to 10 in.)
- *Kochia scoparia* (prebud, up to 15 in.)
- *Monolepis nuttalliana* (prebud, 5-7 in.)

Intermediate control
- *Brassica kaber* var. *pinnatifida* (bud, 10-12 in.)
- *Sonchus arvensis* (top growth control)
- *Cirsium arvense* (top growth control)

Satisfactory control
- *Portulaca oleracea* (flower)
- *Aramanthus graecizans* (stems 12-15 in. long)
- *A. albus* (bud 4-6 in.)
- *A. retroflexus* (bud, up to 15 in.)
- *Solanum triflorum* (prebud 6-8 in.)
- *Helianthus* sp.

Resistant
- *Polygonum convolvulus* (prebud, 18 in.)
- *Lepidium densiflorum*

Regrowth of *Sonchus* and *Cirsium* occurred by the last of August. At 2 lb/A *Lepidium* was the only annual to survive the treatment. (Contribution No. 306 from the Department of Plant Ecology, Univ. of Saskatchewan, Saskatoon, with financial assistance from the Sask. Agric. Res. Foundation.)

CONTROL OF HERBACEOUS PERENNIAL WEEDS

ABSINTH WORMWOOD

Herbicides for absinth control in grass, 1960. Selleck, G. W. Erbon, mixed low-volatile esters of 2,4,5-T, butyl ester of 2,4-D, and low-volatile ester of 2,4-D (L 129) at initial rates of 20 lb/A and a mixture of chlorinated

benzoic and cresoxyacetic acids (CP 1815) at 10 lb/A were applied with a variable-rate sprayer in 34 gal water to duplicated, 15 x 135 ft plots to absinth and a bromegrass-crested wheatgrass pasture on loam soil near Hepburn, Sask. The herbicides were applied May 23, 1958, when absinth was 3 to 4 in. high. Some of the plots received two applications in 1958 and one in 1959, while the remainder received one application in 1958 and one in 1959. The rates (lb/A) of the herbicides required to give 100, 95, 90 and 75% kill September, 1959, are presented below.

Herbicide	Initial date of spray	Rate, lb/A, required to give the percent kill indicated: One spray 1958, one spray 1959				Two sprays 1958, one spray 1959			
		100%	95%	90%	75%	100%	95%	90%	75%
2,4-D-2,4,5-T	May 23	1.5	0.8	0.6	0.5	1.5	0.6	0.4	0.2
2,4,5-T	May 23	2.8	1.6	1.5	1.2	1.6	0.8	0.6	0.4
Erbon	May 23	4.0	3.6	2.8	2.0	8.0	5.0	3.6	2.9
CP 1815	May 23	0.8	0.6	0.4	0.1	1.4	0.8	0.7	0.5
2,4-D ester (L 129)	May 23	1.0	0.8	0.6	0.2	0.7	0.6	0.4	0.2
2,4-D butyl ester	May 23	1.5	1.0	0.7	0.6	1.0	0.7	0.6	0.2
2,4-D butyl ester	June 24	1.5	0.8	0.7	0.4	0.7	0.4	0.2	
2,4-D butyl ester	July 15	1.5	1.0	0.7	0.2				
2,4-D butyl ester	Aug. 20	1.0	0.8	0.7	0.2				

One application in each of two years appears to be more effective than two applications in one year. (Contribution No. 295 from the Dept. of Plant Ecology, Univ. of Saskatchewan, Saskatoon, with financial assistance from the Sask. Agric. Research Foundation.)

Several herbicides for absinth control, 1960. Selleck, G. W. The butyl esters of 2,4-D and MCPA, mixed low-volatile esters of 2,4,5-T, amitrole T, and TBA at initial rates of 20 lb/A in 34 gal water were applied to absinth in a bromegrass-crested wheatgrass pasture with a variable-rate sprayer on duplicated, 15x135 ft plots May 27, 1959 on loan soil at Hepburn, Sask. The initial application was made when the absinth plants were 4 in tall. Half of the plots received a second application to regrowth at similar rates, August 20, 1959. The rates (lb/A) required to give the indicated precent control of absinth and grasses is presented below.

Herbicide	No. of sprayings	Lb/A to give percent control indicated: Absinth, Sept., 1959			Absinth, May, 1960			Grass, May, 1960			
		100	95	75	100	95	75	100	95	75	0
2,4,5-T	2	1.3	—	—	1.2	—	—	—	—	—	12.0
2,4,5-T	1	4.4	2.2	1.3	3.2	2.5	2.1	—	—	—	14.4
2,4-D-2,4,5-T	2	1.2	—	—	1.2	—	—	—	—	—	12.0
2,4-D-2,4,5-T	1	2.8	1.6	1.3	3.0	2.8	1.2	—	—	—	14.4
Amitrole T	2	1.6	1.3	—	1.8	1.3	—	10.0	2.8	1.2	—
Amitrole T	1	2.8	—	1.3	4.3	3.1	2.9	—	—	20.0	4.1
2,4-D	2	1.3	—	—	1.2	—	—	—	—	—	12.0
2,4-D	1	4.2	2.8	1.3	2.8	2.3	1.2	—	—	—	20.0
MCPA	2	1.3	—	—	1.2	—	—	—	—	—	20.0
MCPA	1	5.4	4.2	3.2	6.6	3.5	2.3	—	—	—	20.0
TBA	1	1.3	—	—	3.7	1.5	1.2	—	20.0	7.0	3.7

(Contribution No. 298 from the Dept. of Plant Ecology, Univ. of Saskatchewan, Saskatoon, with financial assistance from the Sask. Agric. Research Foundation.)

CANADA THISTLE AND PERENNIAL SOWTHISTLE

Combination of herbicides and cultural treatments for the control of Canada thistle and sowthistle during the summerfallow year. Forsberg, D. E. During the fallow year of a three year rotation the following treatments were applied after all plots were uniformly worked with a one-way in the spring of 1959 (1) 2,4-D butyl ester applied at 1 lb/A at bud stage and normal tillage resumed after 6 weeks; (2) 2,4-D butyl ester applied at bud stage at 12 oz/A and repeated 2 weeks later, no further tillage; (3) 2,4-D butyl ester applied at bud stage at 8 oz/A, repeated two weeks later, then tilled prior to freeze-up; (4) the butyl ester of 4-(2,4-DB) applied at bud stage at 2 lb/A and normal tillage resumed after 6 weeks; (5) amitrole applied when thistles were 2-6 inches high at 1, 2, 4, 6 and 8 lb/A and normal tillage resumed after 2 weeks; (6) amitrole applied when thistles were 4-6 inches high at 2, and 4 lb/A and normal tillage resumed after 3 weeks; (7) triethylamine salt of 2,3,6-trichlorobenzoic acid (2,3,6-TBA) applied at bud stage at 1 lb/A and resume normal tillage after 6 weeks; (8) 2,3,6-TBA applied at bud stage at 12 oz/A and repeated 2 weeks later no further tillage; (9) 2,3,6-TBA applied at bud stage at 8 oz/A repeated 2 weeks later and till prior to freezeup. The butyl ester of 4-(2,4-DB) and amitrole were the only two herbicides that effected any degree of control. Amitrole at 4, 6 and 8 lb/A resulted in 100% kill of the thistle and yield increases of wheat up to 9 times that of the check plot which yielded 1 bu/A. The length of time the follow-up tillage was delayed did not have any effect on the control obtained. The 4-(2,4-DB) resulted in a yield increase of 7 times that of the check and 100 percent kill of the thistles. (Contribution from Experimental Farm, Research Branch, Scott, Saskatchewan.)

Control of Canada thistle and perennial sowthistle in crop land Forsberg, D. E. On July 5th the following herbicides were applied to a mixed infestation of Canada thistle and perennial sowthistle (var. *glabrescens*) in a stubble crop of barley in the 6 to 8 leaf stage and when the thistles were in the pre-bud and bud stage: 2,4-D butyl ester, MCPA butyl ester and butoxyethanol ester at 4, 8, and 16 oz/A; 4-(2,4-DB) butyl ester and 4-(MCPB) butyl ester at 8, 16, and 32 oz/A. Excellent top growth kill of both weeds was obtained with the butoxyethanol ester when applied at 8 and 16 oz/A. Examination of the root system at harvest time indicated that the root had not been affected and several new shoots were being produced. 4-(2,4-DB) butyl ester at 32 oz/A resulted in 100 percent top kill while 8 and 16 oz caused severe stunting with some plants setting seed. Root examinations showed that the herbicide was translocated to the root. New buds were deformed and brittle while lateral roots were discolored and very brittle. The epidermal layer on the lateral roots showed signs of decay. The 2,4-D butyl ester, MCPA butyl ester and the 4-(MCPB) butyl ester had very little effect on the thistles. (Contribution from Experimental Farm, Research Branch, Scott, Saskatchewan.)

Herbicides for the control of Canada thistle. McCurdy, E. V. A solid stand of Canada thistle was worked in 1959 in the early part of the season, then allowed to grow and herbicides were applied in the bud stage. The plots were worked later in the season, then were treated in the fall with either a butyl ester of 2,4-D at 1 lb/A or 8 or 12 lb/A of amitrole. Little was accomplished with the fall application of the ester but a marked reduction occurred with amitrole at the heavy rate. The Canada thistle was allowed to grow this year until it reached the flower stage, then herbicides were applied. Precipitation was much above normal in the fall of 1959, hence stimulated a strong growth this year. July was very dry at the time of spraying. MCPB applied at 16, 24, and 30 oz/A severly twisted the topgrowth but regrowth approached normal. A butyl ester at 8 and 16 oz/A was no more effective. Amitrole at 6, 8, and 10 lb/A gave some control, but not complete. Ten lb/A was the most effective. Amitrole-T was included at 3 and 6 lb/A. The 3 lb/A rate was not heavy enough but 6 lb/A was more effective. The plots were cultivated in August and herbicides were again applied in September. The effectiveness will be determined in the spring of 1961. (Contributed by the Experimental Farm, Indian Head, Saskatchewan)

XUM

FIELD BINDWEED

Field bindweed control. McCurdy, E. V. A mixture of 54.5% disodium tetraborate pentahydrate, 35.5% disodium tetraborate decahydrate and 8% trichlorobenzoic acid (Benzabor) was applied to field bindweed at ½ and 1 lb/100 sq ft, (total product) in late July, when the weed was in flower. Topgrowth was killed but considerable regrowth occurred with the one-half pound rate. Control was better with one pound but not complete. A CBM (73% disodium octaborate tetrahydrate, 25% sodium chlorate) (Polybor-chlorate) at 2 lb/100 sq ft (total product) did not result in complete eradication. Butyl ester of 2,4-D at more than 2 lb/A gave the weed a very severe setback. (Contributed by the Experimental Farm, Indian Head, Saskatchewan.

Methods of applying PBA for the control of field bindweed. Wiese A. F. and Rea, H. E. In order to determine if it was more effective to apply PBA in single or split applications, 10, 20, 40 and 80 lb/A of a dimethylamine salt of PBA (30% trichloro) were applied to dryland and irrigated wheat fields and retreated as necessary. The plot size was 1 sq rd and the treatments were replicated 3 times. The average rainfall on the dryland area was 20 inches and the irrigated field received from 10 to 15 inches additional water over rainfall. In the dryland field the first application was made in November, 1956. The 10 and 20 lb rates were retreated 6 months later in May, 1957. All plots were weed-free until September, 1958 when a few plants appeared on the plots treated with 40 lb/A. The 80 lb/A plots remained weed free throughout the 2 year period of the experiment.

In the irrigated field the first application was made in March, 1957 and the 10 and 20 lb applications were retreated 6 months later in October. By November, 1958, one year after the retreatment, the 10, 20 and 40 lb/A rates of PBA had weeds growing on them and were retreated. In April, 1959 weeds were only growing on the areas treated with 10 lb of herbicide. Wheat grew normally on the 10, 20, and 40 lb/A treatment 6 months after the first application under irrigated conditions. These tests indicate a slight advantage for split applications of PBA; however, this is offset by additional labor costs and the fact that farmers are not likely to retreat as needed. (Contribution of the Southwestern Great Plains Field Station, Bushland, Texas, Texas Agr. Exp. Sta. and USDA cooperating. Approved as TAES T.A. 3646.)

Effect of PBA and 2,3,6-TBA on field bindweed and other vegetation on highway right-of-way. Wiese, A. F. and Rea, H. E. Dimethylamine salts of PBA (30% trichloro) and 2,3,6-TBA (100% trichloro) were applied at 5, 10, 20 and 40 lb/A to bindweed growing in a buffalograss and blue grama mixture on a highway right-of-way in September, 1958. Each treatment was replicated three times. The soil type was Pullman silty clay loam and the rainfall for the year following application was 23 inches. One year after treatment the bindweed was eradicated by 20 lb/A of TBA and 40 lb of PBA. In June, 9 months after the application, 40 lb/A of PBA and 20 lb/A of TBA had reduced grass stands 50 and 60 percent, respectively, but by fall the grass was recovering and the injury was only 30 and 40 percent. These results indicate that chlorinated benzoic acid herbicides can be used to eradicate bindweed from roadsides without killing existing native grass vegetation common to Southwestern United States. (Contribution of the Southwestern Great Plains Field Station, Bushland, Texas, Texas Agr. Sta. and USDA cooperating. Approved as TAES T.A. 3648.)

FIELD HORSETAIL

Eradication trials of field horsetail using amitrole and and MCPA. Hoyt, P. B. and Carder, A. C. On June 18, July 3, 16, and 30, and August 12, 1959, amitrole at 2, 4, 8, 16, 32, 64 and 128 oz/A and the butyl ester of MCPA at 2 and 4 oz/A were knapsack-sprayed in water at 32 gal/A to duplicate sq-rd plots of dense field horsetail. In 1960 three sq-yard quadrat counts of field horsetail plants were made. For MCPA no reduction in stand occurred from any application. This is not in agreement with previous tests where substantial reductions in stand have usually followed MCPA applications. Amitrole applied on June 18 did not appear to cause reduction in stand. However, when applied at 16 oz/A or higher from July 3 to August 12, inclusive, substantial reductions in number of plants occurred. Applied at this time, the 64 and 128 oz/A rates gave from 90 to 95% kill. (Canada Agriculture, Experimental Farm, Beaverlodge, Alberta.)

Top-growth kill of field horsetail by use of MCPA and 2,4-D. Hoyt, P. B. and Carder, A. C. In the summer of 1960 the herbicides were applied to a dense stand of field horsetail in a 1959 planting of creeping red fescue and a Grey Wooded soil near Beaverlodge. The herbicides were applied in water at 32 gal/A to triplicate sq rod plots. The results are given in the table.

Date of application	Per cent horsetail plants emerged	Av. per cent topgrowth kill*						
			2,4-D butyl ester		MCPA butyl ester			
		Nil	2 oz/A	4 oz/A	2 oz/A	4 oz/A	8 oz/A	16 oz/A
June 28	75	0	5	30	30	83	87	98
July 12	100	0	53	79	89	97	99	100

*Visual estimates.

MCPA was more effective than 2,4-D. Thus, MCPA at 2 oz/A gave as much or more kill that 2,4-D at 4 oz/A. With either herbicide the application on July 12 was much more effective than that on June 28. These results substantiate those of previous tests on a Black soil at High Prairie, Alberta, where horsetail plants grow larger because of a high water-table and higher soil fertility. (Canada Agriculture, Experimental Farm. Beaverlodge, Alberta.)

HOARY CRESS

Control of hoary cress growing under crabapple trees. McCurdy, E. V. Amitrole applied at 8 to 12 lb/A in 1959 to a fairly dense stand of hoary cress growing under crabapple trees, appeared to give excellent control but some regrowth was noted in 1960. Similar regrowth occurred following amitrole-T at 3 and 6 lb/A. These plots were retreated in 1960 with 3 and 6 lb/A of amitrole-T and 8 lb/A of amitrole. The 3 lb/A rate of amitrole-T was not heavy enough to give control but 6 lb/A prevented any further growth this year. The topgrowth was completely controlled by 8 lb/A of amitrole. Neither of the herbicides at the rates used caused any injury to the trees. (Contributed by the Experimental Farm, Indian Head, Saskatchewan)

Chemical control of hoary cress. McCurdy, E. V. Herbicides were applied to plots of hoary cress in June 1959. These plots were later rototilled. Because of a very dry summer, the hoary cress made little regrowth and the effectiveness of the herbicides could not be determined until 1960. On plots where amitrole had been applied at rates of 3, 6 and 9 lb/A, the degree of control increased with the increase in rate, becoming quite effective at 9 lb/A. Amitrole-T at 6 lb/A gave about the same result. A mixture of sodium borate and trichlorophenylacetic acid (XPI-61) at 1 lb/100 sq ft was very slow in action in 1959 but by 1960 had eliminated most of the hoary cress from the plots. Results with this herbicide so far in 1960 have been similar. A combination of the butoxy ethanol ester of 2,4-D (LV-4) at 8 oz/A and amitrole at 6 lb/A resulted in a very rapid kill of topgrowth this year. Amizine (mixture of amitrole and simazine) applied at 15 and 20 lb/A in 1960 resulted in excellent control, particularly at 20 lb/A. The dimethylamine salt of trichlorobenzoic acid (Trysben 200) at 15 lb/A when applied in 1959

XUM

resulted in complete elimination of any hoary cress on these plots by this year. (Contributed by the Experimental Farm, Indian Head, Saskatchewan.)

LEAFY SPURGE

Herbicides on leafy spurge. Coupland, R. T. and Skoglund, N. A. A borate product (61.5% B_2O_3), a BDM (40.9% B_2O_3 and 7% 2,4-D), and 2,4-D amine were applied to a heavy stand of leafy spurge in a pasture on sandy soil near Saskatoon on May 18, 1955 in duplicate 16 x 100 ft. plots. Almost complete control was recorded annually until 1960 from both granular borate treatments except at the lowest rates, while no effect of the 2,4-D amine was seen after 1957. The degree of control in Sept., 1960 is indicated below.

Borate		BDM	
Lb/A*	Pct control	Lb/A*	Pct control
459	95	243	0
918	98	486	90
1837	100	973	100

* Total product

This is the first indication at this station that the effect of borate alone is longer lasting than that of the B-D mixture. Applications of both borate herbicides at approximately the same rates to adjacent plots on Sept. 8, 1955 resulted in 98 to 100% control after 5 years at each of the two higher rates of each herbicide after five years. At the lowest rate the borate alone gave only 50% control, while BDM gave 98% control. The grass stand (*Agropyron repens* and *Poa pratensis*) is now probably more vigorous in the treated plots than in the checks. There is an indication that *Agropyron repens* can withstand heavy rates of borates better than can *Poa pratensis*. (Contribution No. 314 from the Department of Plant Ecology, Univ. of Saskatchewan, Saskatoon, with financial assistance from the Sask. Agric. Res. Foundation.)

Herbicides for leafy spurge control. Selleck, G. W. Butyl ester of 2,4-D, low-volatile ester of 2,4-D (L 129), an invert emulsion of 2,4-D (M 502), and mixed low-volatile esters of 2,4-D-2,4,5-T, at initial rates of 8 lb/A and erbon, TBA, amitrole, amitrole-T, a mixture of chlorinated benzoic and cresoxyacetic acids (CP 1815), methoxy propazine, fenac, and atrazine at initial rates of 20 lb/A were applied to leafy spurge in the late bud stage with a variable-rate sprayer to duplicated, 15 x 100 ft plots in 34 gal/A water June 9, 1959 on sandy loam soil near Saskatoon, Sask. Crested wheatgrass, couchgrass, and native grasses were also present. Second applications were made July 28, 1959, and third applications August 25 to regrowth as indicated below. The rate (lb/A) required to give the designated percent control of leafy spurge and grasses is presented below.

	Lb/A required to give percent control indicated											
	Leafy spurge						Grass					
	Sept., 1959			May, 1960			Sept., 1959			May, 1960		
Herbicide	100	95	75	100	95	75	100	95	0	100	95	0
2,4-D butyl ester[1]	0.4	0.2	—	2.1	1.1	0.6	—	—	8.0	—	—	8.0
2,4-D ester (L 129)[1]	0.3	0.2	—	1.9	1.0	0.8	—	—	4.0	—	—	4.0
2,4-D-2,4,5-T[1]	0.6	—	—	3.0	1.0	0.5	—	—	8.0	—	—	8.0
Erbon[1]	0.6	—	—	3.5	2.0	0.9	—	—	8.0	—	—	7.2
TBA	1.2	0.6	—	3.0	2.0	1.4	3.6	3.3	—	17.0	13.0	3.0
Amitrol T	2.4	1.0	—	—	8.0	7.2	4.8	1.6	1.4	6.0	4.0	—
CP 1815	1.3	0.7	—	2.7	2.3	—	12.0	8.0	—	—	15.0	—
Methoxy propazine[1]	6.8	5.2	—	19.0	16.0	12.0	9.6	5.0	—	4.4	1.0	—
Amitrol[1]	7.6	4.8	—	12.0	—	9.0	12.0	7.6	—	7.0	4.5	—
Fenac[1]	3.2	1.0	—	4.0	3.7	3.1	—	—	—	12.0	4.8	—
2,4-D invert emulsion (M502)[1]	0.3	0.2	—	1.6	1.3	0.9	—	—	8.0	—	—	8.0
Atrazine	—	—	15.0	—	1.6	0.9	8.0	—	4.0	—	7.0	—

[1] Three applications

(Contribution No. 297 from the Dept. of Plant Ecology, Univ. of Saskatchewan, Saskatoon, with financial assistance from Amchem Products Inc.)

Soil sterilants for leafy spurge control. Selleck, G. W. and Skoglund, N. A. A BDM, (DB Granular, sodium borate + 7½% 2,4-D) and XPI-61 (mixture of sodium borate and trichlorophenylacetic acid) were applied at ½, 1 and 1½ lb/100 sq ft total product to leafy spurge in May and Sept. 1959 and a BMM (Ureabor, sodium borate +4% monuron) at 1 lb in Sept., 1959 to standy-loam soil near Saskatoon. The per cent controls of leafy spurge and native and introduced grasses, Sept., 1960, as a result of fall applications, are presented in the following table.

	BDM			XPI61			BMM
Species	½	1	1½	½	1	1½	1
Leafy spurge	0	92	90	0	99	100	0
Grass	0	0	0	50	50	75	100

Spring applications were equivalent to fall applications in grass control but were slightly inferior in the control of leafy spurge. (Contribution No. 307 from the Dept. of Plant Ecology, Univ. of Saskatchewan, Saskatoon, with financial assistance from the Sask. Agric. Research Foundation.)

Relative effect of borate compounds on leafy spurge, 1960. Skoglund, N. A., Coupland, R. T. and Selleck, G.W. Graular treatments made to duplicate 16 x 100 ft. plots on sandy soil near Saskatoon on June 11, 1956 nearly eradicated leafy spurge at the highest rates for each herbicide throughout five growing seasons. The next highest rate gave nearly as good control, except the BMM (Ureabor disodium metaborate + 4%monuron), which had no effect in the fifth year. The degree of control in Sept., 1960 was as follows:

BMM		Gerstley borate (33% B_2O_3)	
Lb/A*	Pct control	Lb/A*	Pct control
236	0	646	75
472	0	1291	95
944	100	2582	98-99
BDM (40.9% B_2O_3; 7% 2,4-D)		61.5% B_2O_3	
259	95	535	100
517	95	1069	100
1034	100	2139	100

* Total product

The two lower rates of the BMM resulted in a taller, denser stand of leafy spurge than the checks. The stand of grasses has recovered from all treatments, except from the BMM. The latter herbicide has completely prevented regrowth of grass, even at 118 lb/A. In several of the plots there is an indication that *Agropyron repens* has survived better than other grasses and that the grass stand has been invigorated. (Contribution No. 315 from the Department of Plant Ecology, Univ. of Saskatchewan, Saskatoon, with financial assistance from the Sask. Agric. Res. Foundation.)

QUACKGRASS

Comparative effect of herbicides for couchgrass eradication. Carder, A. C. During mid-June, 1959, 11 herbicides were applied to a vigorous and continuous stand of couchgrass 1 ft high. Plots were 1 sq rod and triplicated. Soil was a rather heavy clay loam with adequate drainage. Weather at application time was dry but light showers occurred during the following 2-3 weeks, although no heavy rains fell till 2 months after treatment. TCA, erbon and monuron were applied by knapsack sprayer using 160 gal/A water, other herbicides applied dry. The results are given in this table.

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Herbicide	Oz/sq rod active ingredient	Av. per cent couchgrass at max.
TCA	8	16
	10	21
	12	8
	14	14
Erbon	8	5
	10	3
	12	0
	14	0
Monuron	2	13
	4	1
	6	0
	8	0
Simazine	2	4
	4	1
	6	0
	8	0.7
Monuron TCA (Urox)	2	18
	3	22
	4	20
	5	20

Herbicide	Lb/sq rod actual product	Av. per cent couchgrass at max. kill
Concentrated Borascu[1]	8	58
	12	27
	16	18
	20	14
Atlacide[2]	2	77
	4	37
	6	37
	8	14
CBMM (Chlorea[3])	2	25
	4	4
	6	3
	8	0.3
BBM (Ureabor[4])	3	3
	4	0.3
	5	0.3
	6	0
CBM (Polybor chlorate[5])	6	45
	8	32
	10	15
	12	15
Sodium chlorate[6]	2	60
	4	24
	6	12
	8	3

[1] Borax 91% (Boron eq. 19.5%)
[2] Sodium chlorate 59%
[3] Monuron 1%, sodium chlorate 40%, sodium metaborate 57% (Boron eq. 4.5%)
[4] Monuron 4%, disodium tetraborate pentahydrate 63%, disodium tetraborate decahydrate 31% (Boron eq. 13%)
[5] Disodium octaborate tetrahydrate 73%, sodium chlorate 25%
[6] Sodium chlorate 99%

Erbon at 10, monuron at 4 and simazine at 4 oz/sq rod active, and Chlorea at 8 and Ureabor at 4 lb/sq rod actual gave 99% or more kill of couchgrass, while erbon at 12, monuron at 6 and simazine at 6 oz/sq rod, and Ureabor at 6 lb/sq rod gave eradication. It is of note that TCA, Atlacide and sodium chlorate did not eradicate at rates used, the heaviest of which are above those normally recommended for these herbicides. Field observations suggest that monuron, simazine and Ureabor had not reached their maximum lethal action by the autumn of 1960. (Canada Agriculture, Experimental Farm, Beaverlodge, Alberta.)

Treatment of couchgrass with monuron alone and combined with tillage. Carder, A. C. Couchgrass on shallow black loam soil was treated in late spring and early fall of 1952 with monuron. At each time, treatments were made after about 20 in. of leaf growth were mowed and raked off. The chemical was knapsack-sprayed on duplicate sq-rod plots in water suspension at the rate of 80 gal/A. Procedure and results are given in the table.

Treatment	Monuron lb/A	Av. per cent* of couchgrass in given years following treatment 1	2	3	4	5	6	7	8
Monuron on undisturbed sod	10	15	8	12	8	15	23	30	52
	20	5	0	2	2	8	14	20	26
	40	1	0	0	0	0	0	4	7
	80	0	0	0	0	0	0	2	3
Monuron, one-wayed 2 weeks later	10	18	40	48	62	80	50	82	80
	20	10	6	6	8	15	11	25	38
	40	5	0	0	0	4	3	11	20
	80	1	0	0	0	1	1	4	7
One-wayed, monuron applied	10	28	48	35	82	82	60	82	82
	20	15	5	2	2	11	13	28	35
	40	8	1	0	0	2	3	11	18
	80	2	0	0	0	2	2	4	8
One-wayed, monuron applied, one-wayed	10	15	25	20	32	41	33	70	71
	20	12	8	5	6	11	23	55	60
	40	5	0	0	0	3	2	6	12
	80	1	0	0	0	2	1	6	11

* Visual estimates by same appraiser.

Results from the fall treatments are not given in the table since they closely parallel those from the spring application, except that they were generally less effective. Observing this fact and the above data, monuron was most effective when applied in the spring on undisturbed sod. Applied thus, 20 lb/A gave complete kill although re-establishment was initiated fairly soon thereafter from surrounding untreated areas. With tillage, 40 lb/A were necessary for eradication. Where 40 and 80 lb/A were applied in the spring to undisturbed sod the couchgrass did not invade till the 7th year following treatment, while in every instance where cultivation was involved regrowth occurred in the 5th year. (Canada Agriculture, Experimental Farm, Beaverlodge, Alberta.)

Spring applications of dalapon combined with tillage for the control of couchgrass. Carder, A. C. In the late spring of 1958 dalapon was applied at different rates to a continuous infestation of couchgrass 8 in. high. The herbicide was delivered in water solution at the rate of 20 gal/A from a boom plot sprayer to quadruplicate 2-sq-rod plots. Three weeks later the area was double one-way disced crosswise, followed in 6 weeks with another application of herbicide when the couchgrass resprouts were 4 in high. Further double one-way discings were given 2 weeks and 8 weeks after this herbicide treatment. The effects of the different treatments were appraised in 1959 and 1960. Rates of herbicide used and results are given in the table.

Dalapon lb/A 1st. applic.	2nd. applic.	Total	Av. per cent* of couchgrass Yr. following treatment Early summer	Autumn	2nd yr. following treatment Early summer	Autumn
0	0	0	16	33	53	79
8	4	12	10	17	34	58
6	6	12	5	11	27	45
10	5	15	8	12	26	45
8	8	16	5	9	20	46
12	6	18	5	9	25	40

* Visual estimates by same appraiser.

Because of the extremely dry conditions in 1958 the 3 tillage operations alone gave 84% control of the couchgrass. This is an unusually high degree of kill for so few tillage operations. However, normal, rapid recovery followed. The data suggest that where dalapon is used the second application rate should equal the first. Best control with dalapon was 95%. As with tillage recovery was rapid subsequent to maximum kill early in the year following treatment. (Canada Agriculture, Experimental Farm, Beaverlodge, Alberta.)

Autumn applications of dalapon combined with tillage for the control of couchgrass. Carder, A. C. In the late fall of 1958 a pure couchgrass sod was broken by stubble-plow and left undisturbed over winter. At first regrowth in the spring, the sod was worked down by disc-harrow. At mid-June when a fresh regrowth was 4 in high dalapon was applied at different rates. The herbicide was delivered in water solution at the rate of 20 gal/A from boom plot sprayer to quadruplicate 2-sq-rod plots. Two weeks later the area was double one-way disced crosswise, followed in 6 weeks by a second double one-way discing. The effects of the different treatments were appraised in 1960. Rates of herbicide used and results are given in the table.

Herbicide	lb/A	Av. per cent* of couchgrass in year following treatment Early summer	Autumn
Dalapon			
	0	30	78
	8	12	31
	12	8	16
	16	7	16
	20	4	9
Simazine			
	8	12	10
	12	10	8

* Visual estimates by same appraiser.

The 4 tillage operations alone gave a maximum kill of 70% but couchgrass recovery was rapid. Increasing the dosage of dalapon increased the degree of maximum kill, with the 20-lb rate giving 96% control. Recovery from the effects of dalapon set in early. Simazine at equal rates to dalapon gave about the same degree of kill, but the maximum effectiveness of simazine was more slowly obtained. (Canada Agriculture, Experimental Farm, Beaverlodge, Alberta.)

Applications of fenac combined with tillage for the control of couchgrass. Carder, A. C. In the spring of 1959 an 8-in high stand of dense couchgrass was treated with fenac. The herbicide was applied in water at the rate of 20 gal/A from a boom plot sprayer. Plots were 2 sq rods and in triplicate. Three weeks later the area was double one-way disced, the second working crosswise to the first. This was followed by a single one-way discing one month later. Effects were appraised in 1960.

	Av. per cent survival year following treatment*	
Fenac lb/A	Early summer	Autumn
0	52	70
4	20	18
8	10	7
12	6	3

* Visual estimates by same appraiser.

The 2 cultivations alone reduced the stand of couchgrass almost 50%, but recovery was rapid. No application of fenac combined with tillage produced eradication, but 12 lb/A gave 97% control. The maximum effect of fenac would appear to be obtained well over a year from time of application. (Canada Agriculture, Experimental Farm, Beaverlodge, Alberta.)

Effect of amitrole-T on couchgrass. Corns, Wm. G. Duplicate 100 square-foot plots of *Agropyron repens* were sprayed with 5, 10, and 20 lb/A amitrole-T in 50 gal/A water on June 22, 1960, when the grass was about 9 inches tall, 20 days after clipping the sod. On July 20, half of each plot was rototilled. On Sept. 7, 1960 the number of live shoots of grass per square foot were counted and the means are shown in the table.

Amitrole-T	Roto-tilled		Not roto-tilled	
lb/A	Count	Pct.	Count	Pct.
Check	73	100	184	100
5	37	51	130	71
10	34	47	122	66
20	51	70	113	62

Rototilling improved the control of the couchgrass but the results from the use of the herbicide were rather unsatisfactory. (Division of Crop Ecology, Dept. of Plant Science, Univ. of Alberta).

Herbicide combinations for quackgrass control. Meggitt, W. F. On May 5, 1960, several herbicides were applied to plots 24 feet by 24 feet in a heavily infested quackgrass sod. The herbicides were amitrole-T at 2 and 4 lb/A, dalapon at 2, 4, and 8 lb/A, and fenac at 2 and 4 lb/A. In combination with these treatments was atrazine at 2 and 4 lb/A on May 5 as a pre-plowing treatment, 2 lb/A pre-emergence (May 25), and 2 lb/A post-emergence (June 18). The area was plowed on May 16 and Michigan 425 field corn was planted on May 17 and May 25 at approximately 17,500 seeds per acre. Two rows of each plot were cultivated when the corn was approximately 18 inches tall. All herbicides were applied in water at a rate of 31 gal/A. Annual broadleaved weeds were controlled by 2,4-D amine formulation, in all plots where atrazine was not applied.

Amitrole-T at 2 lb/A pre-plowing plus atrazine at 2 lb/A applied pre-emergence gave 92% control of quackgrass. Control from amitrole-T at 4 lb/A plus atrazine was slightly better at 98%. Amitrole-T as a pre-plowing application at 2 and 4 lb/A alone gave 80 and 90% control.

Dalapon at 2 lb/A plus atrazine 2 lb/A pre-emergence provided 75% control; dalapon at 4 lb/A plus atrazine 92%. Dalapon at 2 and 4 lb/A alone were not satisfactory while 8 lb/A gave over 95% control.

Atrazine as a pre-plowing treatment at 4 lb/A gave 92% control of quackgrass; 2 lb/A gave 75%. Pre-emergence or post-emergence applications of atrazine without pre-plowing applications, although they provided a measurable amount of quack grass control, were not satisfactory in that the control was less than 50%.

Fenac in combination with atrazine gave 95% control of quackgrass. However, the corn was injured by 2 and 4 lb/A at both dates of planting. Dalapon at 4 lb/A injured corn at both dates of planting and 8 lb/A caused very severe corn injury. (Dept. of Farm Crops, Michigan Agr. Exp. Sta.)

TOADFLAX

Control of toadflax by 2,4-D in combination with a competitive grass. Carder, A. C. An area heavily infested with toadflax was partially fallowed in 1952, fitted for planting in the spring of 1953 when half of the area was sown without nurse crop to creeping red fescue and half to brome. Good stands of grass were obtained along with a considerable growth of toadflax seedlings and resprouts from old root sections. In summers of 1953 and 1958 when the toadflax was in late bud, the butyl ester of 2,4-D was applied by boom sprayer at nil, 1, 2, 3 and 4 lb/A in water at 10 gal/A to quadruplicated 2 sq rod plots. In the summer of 1959 the area was plowed and worked down by disc harrow. A further discing was given in the spring of 1960 after which the area was left undisturbed. Appraisal of toadflax suppression was made in the fall of each year of herbicidal treatment and in the fall of 1960.

Grass	Lb/A	Av. per cent survival and recovery of toadflax*						
inclusion	2,4-D	1952	1954	1955	1956	1957	1958	1960
Creeping red fescue	0	80	50	22	14	13	6	64
	1	72	34	10	6	4	2	74
	2	64	26	9	4	2	0.4	82
	3	32	14	8	3	2	0.5	78
	4	24	10	7	3	1	0.1	79
Bromegrass	0	80	40	10	3	3	1	39
	1	48	30	6	3	2	0.5	38
	2	40	24	6	3	2	0.5	36
	3	24	13	3	1	0	0	38
	4	24	9	2	1	1	0	42

* Visual estimates by same appraiser.

The meadow grasses offered over the course of time heavy competition to toadflax even without the application of 2,4-D. Brome seemed particularly aggressive. The additional suppressive effect of the 2,4-D treatments on the toadflax was marked at first but decreased in subsequent years. Where 3 and 4 lb/A of 2,4-D were used each year for 6 years combined with bromegrass, the toadflax disappeared, and where 1 and 2 lb/A with brome and 2 and more lb/A with fescue were used the toadflax was almost eliminated. Wherever one or more pounds of 2,4-D were applied no viable toadflax seed was produced in any year. However, a heavy growth of toadflax infested the area in 1960, following breaking. This growth was as heavy in the 2,4-D treated plots as in the checks. On those plots where the toadflax had disappeared before breaking, this new growth consisted of seedlings; in the remaining plots an occasional more developed plant appeared to have arisen from old root sections. (Canada Agriculture, Experimental Farm, Beaverlodge, Alberta.)

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Herbicides for toadflax control. Forsberg, D. E. In July of 1959 the following herbicides were applied to a heavy infestation of toadflax in a stand of Russian wild rye grass: amitrole-T, 2,3,6-TBA, PBA, and fenac. Each of the herbicides was applied at 1, 4, and 6 oz/100 sq ft in ½ gal/A water. In the fall of 1960 amitrole-T had no effect on the toadflax. 2,3,6-TBA had eliminated both the grass and toadflax at the 4 and 6 oz rate. PBA had no effect on the grass but had eliminated toadflax at all rates used. Fenac also had no effect on the grass and had eliminated toadflax at all rates used. (Contribution from Experimental Farm, Research Branch, Scott, Saskatchewan.)

Herbicides for toadflax control. Selleck, G. W. 2,3,6-TBA, a 1:1 mixture of atrazine and methylpropazine, amitrole, amitrole-T, and fenac were applied with a variable-rate sprayer to duplicated, 15 x 135 ft plots of toadflax and couchgrass, at an initial rate of 40 lb/A in 34 gal water on sandy loam soil near Hague, Sask., May 26, 1959. Toadflax plants were 4 in. high when sprayed. A second application was made to regrowth August, 1959. The rates (lb/A) required to give the indicated percent control of toadflax and grasses are presented in the table.

	Lb/A required to give percent control indicated											
	Toadflax						Couchgrass					
	Sept., 1959			May, 1960			Sept., 1959			May, 1960		
Herbicide	100	95	75	100	95	75	100	95	75	100	95	0
Atrazine + methyl propazine	22.4	13.6	6.0	8.0	5.6	5.0	24.0	16.0	6.4	4.0	2.8	2.4
Amitrole	....	....	....	5.0	4.2	3.6	....	....	....	....	40.0	....
TBA	4.0	2.8	....	5.0	....	4.2	....	24.0	14.4	....	40.0	7.0
Amitrole-T	....	....	....	4.3	4.0	3.2	....	....	....	16.0	9.0	....
Fenac	5.6	2.5	....	4.0	2.9	2.4	....	25.0	6.4	....	40.0	8.8

(Contribution No. 296 from the Dept of Plant Ecology, Univ. of Saskatchewan, Saskatoon, with financial assistance from the Sask. Agric. Research Foundation.)

Several herbicides for toadflax and couchgrass. Selleck, G. W. Amitrole was applied June 4, June 24, July 15, August 20 and September 8, 1958, and a butyl ester of 2,4-D, mixed low-volatile esters of 2,4-D-2,4,5-T, mixed low volatile esters of 2,4,5-T, 2,3,6-TBA and erbon, each at an initial rate of 20 lb/A, and a mixture of chlorinated benzoic and cresoxyacetic acids (CP 1815) at 6 lb/A, were applied September 8, 1958 with a variable-rate sprayer to duplicated, 15 x 100 ft plots in 34 gal/A water on sandy loam soil near Hague, Sask. The herbicides were applied to toadflax in bromegrass, couchgrass and native grasses. The plots were retreated at similar rates when regrowth of toadflax reached a height of 3 to 4 in. The rate (lb/A) required to give the indicated percent control of toadflax and grasses May 26, 1960 is presented in the table.

Initial treatment date, 1958	Hericide	No. of sprayings	Lb./A to give percent control indicated					
			Toadflax			Grass		
			100	95	75	100	95	75	0
June 4	Amitrole	3	6.4	4.5	4.2	20.0	10.0	5.3	2.8
June 24	Amitrole	2	10.0	8.7	7.2	15.0	8.8	5.2	1.6
July 15	Amitrole	2	20.0	16.0	10.0	....	....	4.4	2.8
July 15	Amitrole	3	4.0	3.7	3.3	20.0	....	7.2	2.8
Aug. 20	Amitrole	2	4.8	4.2	3.2	20.0	....	7.2	....
Sept. 8	Amitrole	2	6.8	3.5	2.6	....	20.0	8.4	....
Sept. 8	CP 1815	2	3.4	1.7	1.3	....	....	....	6.0
Sept. 8	Erbon	3	....	....	20.0	....	....	....	10.0
Sept. 8	2,4-D	3	....	....	20.0	....	....	....	20.0
Sept. 8	2,4-D-2,4,5-T	3	....	....	20.0	....	....	....	15.0
Sept. 8	2,4,5-T	2	9.0	5.2	4.4	....	....	....	12.4
Sept. 8	2,3,6-TBA	2	2.1	....	1.6	....	....	....	12.4

More effective control of toadflax was obtained when the initial application was made in the fall.

(Contribution No. 299 from the Dept. of Plant Ecology, Univ. of Saskatchewan, Saskatoon, with financial assistance from Amchem Products Inc.)

Herbicides for Dalmatian toadflax. Selleck, G. W. and Alex, J. F. Borax, a BDM (DB Granular, disodium tetraborate + 7.5% 2,4-D), and butyl ester of 2,4-D were applied to triplicated, 10 x 10 sq ft plots on gravelly loam near Saskatoon, Sept. 9, 1958. The percent control of Dalmatian toadflax and native grasses, Sept. 1959, is given in the table.

	BDM,* lb/100 sq ft			Borax,* lb/100 sq ft			2,4-D, lb/A			
Species	1	2	4	½	1	2	2	4	8	16
Toadflax	45	100	100	98	100	100	50	75	50	50
Native grasses	0	75	100	0	0	75	0	0	85	100

* Total product.

An examination of the plots Sept., 1960 revealed that the control was deteriorating with 2,4-D but was maintained as above with borax and the BDM. (Contribution No. 306 from the Dept. of Plant Ecology, Univ. of Saskatchewan, with financial assistance from Sask. Agr. Foundation.)

OTHER PERENNIAL WEEDS

Russian knapweed control. McCurdy, E. V. An area of Russian knapweed growing in competition with brome, last treated with herbicides in 1958, was examined in 1960 to observe the regrowth of brome and any reappearance of this weed. Brome was beginning to encroach the treated area on the plots that had received up to 15 lb/A of trichlorobenzoic acid, but where the rate had been from 20 to 25 lb/A the plots were still bare. Only a few stunted Russian knapweed could be found on the plots where the rates of 2,3,6-TBA had been 15 lb/A or higher. The grass was beginning to come back more rapidly on plots treated with polychlorobenzoic acid (Benzac 354) at 5 and 10 lb/A. A few more knapweed plants were noted on these plots. The plots were still bare where a CBM (Polybor-chlorate, disodium octaborate 73%, sodium chlorate 25%) at 3 lb/100 sq ft had been applied, but a few plants were making some growth where the rate had been 2 lb/100 sq ft. (Contributed by the Experimental Farm, Indian Head, Saskatchewan.)

Soil sterilants for perennial weed control, 1960. Selleck, G. W. A BDM, (DB Granular, disodium tetraborate pentahydrate 55% disodium tetraborate decahydrate 35.5%, 2,4-D, 7½%), a BMM, (Ureabor, disodium tetraborate pentahydrate 63.2% disodium tetraborate decahydrate 30.8%, monuron 4%) XPI 61 (mixture of sodium borate and trichloropenylacetic acid), XPI 62 (mixture of sodium borate, monuron and 2,3,6-TBA), XPI 63 (mixture of a BMM and trichlorophenylacetic acid). XPI 29 (mixture of sodium borate and simazine) and XPI 69 (mixture of sodium borate and atrazine) were applied to duplicated, 100 sq ft plots at rates from 1 to 2½ lb on loam soil at Smales, Sask., May 28,1959. The percentage of control of absinth, dandelion and grass, Sept., 1960, are presented in the following table.

Plant species	Rate lb/100 sq ft	BMM	BDM	XPI 29	XPI 62	XPI 63	XPI 69
Absinth	1	100	50	100	100	100	100
	1½	100	100	100	100	100	100
	2½	100	—	100	100	100	100
Dandelion	1	90	65	80	85	55	70
	1½	95	37	85	85	90	100
	2½	97	—	100	97	98	100
Grass	1	100	35	100	100	100	100
	1½	100	40	24	100	100	100
	2½	100	—	100	100	100	100

The control of these species was better in 1960 than in 1959 with the following herbicides: the BMM, XPI 62, XPI 63 and XPI 69. Control was roughly equivalent both years with XPI 29 and better in 1959 with the BDM. *Rosa* sp. were controlled 100% by both XPI 62 and XPI 63 at 2½ lb/100 sq ft. XPI 63 and XPI 69

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each at 1½ lb failed to control roses, as did the BMM at the heaviest rate of application. (Contribution No. 305 from the Dept. of Plant Ecology, Univ. of Saskatchewan, Saskatoon, with financial assistance from the Sask. Agric. Research Foundation.)

Borate compounds for perennial weed control, 1960. Selleck, G. W. and Skogland, N. A. XPI 61 (mixture of sodium borate and trichlorophenylacetic acid), XPI 62 (mixture of sodium borate, monuron, and TBA), XPI 69 (mixture of sodium borate and atrazine), and disodium tetraborate +8% TBA (Benzabor) were applied to duplicated, 100 sq ft plots at rates of ½, 1, and 2 lb/A total product on sandy loam soil at Saskatoon, Sask., Nov. 5, 1959. The percentage control of hoary cress, dandelion, Canada thistle and native grasses, May, 1960, are presented below.

Herbicide	Rate lb/100 sq ft	Hoary cress	Dandelion	Canada thistle	Grass
XPI 61	½	0	0	100	0
	1	45	0	—	5
	2	95	75	100	40
XPI 62	½	0	0	—	40
	1	0	0	—	90
	2	0	35	100	92
XPI 69	½	0	0	80	77
	1	0	0	0	90
	2	0	0	50	80
Benzabor	1	0	85	100	0
	2	45	87	100	45
	3	50	100	100	65

(Contribution No. 304 from the Dept. of Plant Ecology, Univ. of Saskatchewan, Saskatoon, with financial assistance from the Sask. Agric. Research Foundation.)

Bur ragweed eradication with soil sterilants. Wiese, A. F. and Rea, H. E. Various soil sterilants were applied in October, 1958 to bur ragweed growing on Pullman silty clay loam soil. The plots were duplicated 1 sq rd. The average rainfall is 20 inches. The sterilants applied and the lb/sq rd were a DBM (92.5% sodium borate plus 7.5% 2,4-D) at 4 and 6; sodium chlorate at 3, 5, and 7; sodium tetraborate (Concentrated Borascu) at 12, 16, and 20; monuron at ¼, ⅜, and ½; fenuron at ¼, ⅜, and ½; dimethylamine salt of PBA (30% trichloro) at ⅛, ¼, and ½; dimethylamine salt of 2,3,6-TBA (100% trichloro) at 1/16, ⅛, and ¼; sodium salt of fenac at 1/32, 1/16, and ⅛; and erbon at ½, 1, and 2. One year after treatment soil sterilants and lb/sq rd which averaged 90 or more percent control were sodium chlorate at 5 and 7, PBA at ¼, TBA at ¼, and fenac at ⅛. Other herbicides tested were not satisfactory. (Contribution of the Southwestern Great Plains Field Station, Bushland, Texas, Texas Agr. Exp. Sta. and USDA cooperating. Approved as TAES T.A. 3650.)

Indian rushpea controlled with soil sterilants. Wiese, A. F. and Rea, H. E. During 1957 and 1958 several soil sterilants were applied to Indian rushpea. The soil type was Pullman silty clay loam and the average rainfall in the area was 20 inches. The plots were 1 sq rd and the treatments were duplicated each year. The sterilants applied and lb/sq rd were a DBM (92.5% sodium borates plus 7.5% 2,4-D) at 4 and 6; sodium chlorate at 3, 5, and 7; sodium tetraborate (Concentrated Borascu) at 12, 16, and 20; monuron at ¼, ⅜, and ½; fenuron at ¼, ⅜, and ½; amine salt of PBA (30% trichloro) at ⅛, ¼, and ½; erbon at ½, 1, and 2; sodium salt of fenac at 1/32, 1/16, and ⅛ and dimethylamine salt of 2,3,6-TBA (100% trichloro) at ⅛, ¼, and ½. 2,3,6-TBA was applied only in 1958. Sterilants and the minimum lb/sq rd which eradicated the weed both years were fenuron 60, erbon 2, PBA 40, 2,3,6-TBA 20, and fenac 5. (Contribution of the Southwestern Great Plains Field Station, Bushland, Texas, Texas Agr. Exp. Sta. and USDA cooperating. Approved as TAES T.A. 3649.)

Spot treating Johnsongrass in cotton in Northwest Texas. Wiese, A. F. and Scott, Dwane. During 1957, 1958, and 1959, 50-50 naphtha-diesel oil mixture, ½ gal of hexachlorocyclopentadiene (C-56) in 100 gal of diesel oil, 2 gal hexachloroacetone (HCA) in 100 gal of diesel oil, 8.5 lb of sodium salt of dalapon in 100 gal of water, and 4.3 lb of sodium salt of dalapon in 100 gal of water were tested for spot treating Johnsongrass in cotton in Hall, Collingsworth and Wheeler counties in the Panhandle of Texas. Each plot was 4 rows of cotton 300 ft long. Two row check plots were left between each plot. One replication of the treatments was applied in each county each year. The materials were applied each time the Johnsongrass was 6 to 8 inches tall which required 3 or 4 applications annually, depending upon moisture. Control of 95 to 100 percent of the old grass stands was obtained with all materials. Cost of material and labor for control of a 30% infestation of Johnsongrass was about 12 dollars per A. This was as cheap or cheaper than hoeing, which did not control Johnsongrass. (Contribution of the Southwestern Great Plains Field Station, Bushland, Texas, Texas Agr. Exp. Sta. and USDA cooperating. Approved as TAES T.A. 3647.)

WEED CONTROL IN FIELD CROPS

CORN

Weed control in corn by various granular formulations of atrazine and simazine. Ascheman, R. E. and Bondarenko, D. D. Corn (hybrid C-38) was planted in 42-inch rows in Miami-Brookston silty clay loam at Columbus on June 7, 1960. Triplicate plots randomized in blocks were treated pre-emergence by each formulation listed in the following table, at 2 lb/A (overall rate) on June 8. The granular materials were applied in 14-inch bands, the atrazine wettable powder, which was included for comparison, in 40 gpa water (overall rate) in 20-22-inch bands. The plots had a natural infestation of redroot, pigweed, lambsquarters, green foxtail, and yellow foxtail. The ratings were made on July 5 before cultivation and were the average of the three replications.

All the granular and wettable powder formulations of atrazine and simazine reduced the weed populations 95 to 100%.

Herbicide and formulation	Rating* of effect on Corn	Pigweed and lambsquarters	Green foxtail and yellow foxtail
Atrazine granules (8% active ingredient, Attaclay carrier)			
W-15/30**	0	9.9	9.8
T-15/30	0	10.0	10.0
W-20/35	0	9.8	9.5
T-20/35	0	10.0	10.0
W-24/48	0	9.7	9.7
T-24/48	0	9.9	10.0
W-30/60	0	9.7	9.8
T-30/60	0	9.8	9.8
Atrazine granules (ammonium sulfate carrier)			
10% G	0	10.0	10.0
15% G	0	10.0	10.0
20% G	0	10.0	10.0
Simazine granules (ammonium sulfate carrier)			
8% G	0	10.0	10.0
15% G	0	10.0	10.0
17% G	0	9.9	10.0
Atrazine, 80% wettable powder applied in water	0	10.0	10.0

*Rated on basis of 0 = no apparent effect, 10 = all plants killed.

**Source of active ingredient: W = wettable powder, T = technical grade.

(The Ohio Agr. Exp. Sta.)

Herbicides on corn. Bondarenko, D. D., Ascheman, R. E. and Stroube, E. W. Hybrid C-38 corn was planted in 42-inch rows in Miami-Brookston silty clay loam at Columbus on May 5, 1960. Hybrid W-64 corn was planted in 40-inch rows in Brookston silty clay loam at the Western Substation on May 16, and in 42-inch rows in Hoytville silty clay loam at the Northwestern Substation on May 24. The plots had a natural infestation of redroot pigweed and lambsquarters at Columbus, Pennsylvania smartweed and Venice mallow at Western, redroot pigweed, lambsquarters, velvetleaf, and common ragweed at Northwest. German millet was broadcast in the plots at Columbus to simulate annual grass weeds. All liquid and wettable powder formulations were applied in 40 gpa water (overall rate) in 20-22-inch bands. Granular formulations (at Columbus only) were applied in 14-inch bands. A 1-inch rain occurred one hour after the herbicides were applied pre-emergence at Western. Moderate rains followed pre-emergence applications at Columbus and at Northwest. Triplicate 4-row plots were treated by the following herbicides (rates in lb/A).

Pre-emergence, applied on date of planting at all locations: atrazine at 2 and 3; simazine at 2 and 3; simazine + atrazine at 1 + 1 and 1½ + 1½; 2,4-DEP at 4 and 6; HN-1688 (methyl dichlorobenzoic acid) at 2 and 4; HN-1763 (nitrotrichlorobenzoic acid) at 4 and 8; PGBE (propylene glycol butyl ether) ester of 2,4-D at 2; PGBE ester of 2,4-D + CDAA at 1 +2 and 1 + 3; CDAA at 4; CDAA + trichlorobenzyl chloride, referred to as CDAA-T, at 3 + 7½ and 4 + 10; diuron at 2 pints of commercial formulation; and 2,3,6-TBA (28% dimethylamine salt of trichlorobenzoic acid and 1.3% dimethylamine salts of other polychlorobenzoic acids) at 2. At Columbus granular formulations of atrazine, simazine, simazine + atrazine, PGBE ester of 2,4-D, and PGBE ester of 2,4-D + CDAA were applied at the same rates as the corresponding liquid and wettable powder formulations mentioned above.

Post-emergence, 4-6-leaf stage at Columbus, 2-4-leaf stages at Western, none applied at Northwest: dimethylamine salt of 2,4-D at ½; PGBE ester of 2,4-D at ¼; 2,3,6-TBA at 2; diuron at 2 pints commercial formulation; and alkanolamine salts of DNPB at 3. In addition: at Columbus, dimethylamine salt of 2,4-D at 8, amitrole and amitrole-T at 1; and at Western, atrazine at 3.

The weed control results following were on the basis of good = 90% to 100% reduction in weed populations, fair = 70% to 89%, poor = less than 70%.

Pre-emergence results: atrazine, simazine and atrazine + simazine good at all rates at all locations; 2,4-DEP good at Columbus and Northwest, poor at Western; HN-1688 good on all broadleaf weeds, fair on millet; HN-1763 good at Columbus and Northwest, fair at Western; PGBE ester of 2,4-D alone and in combinations with CDAA good at Northwest, fair at Columbus, poor at Western; CDAA alone poor at all locations; CDAA-T good to fair at Northwest, fair to poor at Columbus, poor at Western, diuron good at Northwest, fair at Columbus and Western; 2,3,6-TBA good at Columbus and Western, fair at Northwest.

Corn treated pre-emergence by HN-1688 at 4 and HN-1763 at 8 at all locations showed slight damage early in the season but recovered completely. No other pre-emergence treatment damaged the corn.

The granular formulations applied at Columbus, gave results similar to the corresponding liquid and wettable powder formulations.

Post-emergence results, broadleaf weeds: dimethylamine salt of 2,4-D at ½ and 2,3,6-TBA good at Western, fair at Columbus; PGBE ester of 2,4-D fair; diuron fair at Western, poor at Columbus; DNBP good at Western, poor at Columbus; dimethylamine salt of 2,4-D at 8 (at Columbus) good; amitrole and amitrole-T (at Columbus) fair on pigweed, poor on lambsquarters; and atrazine (at Western) good. Annual grass: amitrole and amitrole-T gave fair control of the millet at Columbus; the other post-emergence treatments gave poor control.

Corn treated post-emergence by amitrole and amitrole-T at 1 and dimethylamine salt of 2,4-D at 8 showed slight damage early in the season but recovered. No other post-emergence herbicide damaged the corn. (The Ohio Agr. Exp. Sta.)

Control of weeds in corn with herbicides used pre-emergence. Freeman, J. F. Corn, hybrid Ky. 105, was planted 3 inches deep in Captina silt loam soil at Lexington, June 7, 1960. Four-row plots having 2 middle rows treated and the outside rows untreated as check were used, with treatments quadruplicated. Herbicides were applied in 13 inch bands centered over the rows—those sprayed-on being used in water at rate of 39 gal/A broadcast basis and granular (G) materials being applied with a commercial-type applicator adapted to use on bicycle-wheel sprayer chassis. Actual rate of spray and herbicides used was 1/3 that of the indicated solid-coverage rates. Soil-incorporated treatments had the herbicides chopped into the soil with a potato hoe to a depth of 1½-2 inches immediately after application. Rains of about 1/3" fell 2 days after treatment, 2" during first week and 8 inches during the second week following emergence of corn. Redroot pigweed, crabgrass, foxtail and goosegrass were principal weeds. The number of broadleaf and grass weeds present in 9" x 20' area of the treated band of each treated row and in a like area of the untreated rows of each plot was determined during 4th week after corn emerged. The percentage reduction in broadleaf and grass weeds (based on adjacent untreated rows which averaged 5.5 broadleaf + 5.9 grass weeds/sq ft) is shown with each treatment (rates lb/A). Fenac-sodium salt, ½, 70 and 44%; 1, 85 and 37%; 2. 94 and 77%; CDAA plus trichlorobenzyl chloride (Randox-T) 3.1 + 7.9, 87 and 50%; 2,4-DEP 4, 87 and 58%; EPTC 2, incorp., 58 and 81%; 3 surface, 52 and 77%; EPTC (G) 3, surface, 57 and 69%; *n*-propyl di-*n*-propylthiolcarbamate (R-1607) 2, incorp., 82 and 87%; 4 incorp., 94 and 97%; 6, incorp., 97 and 99%; R-1607 (G) 4, incorp., 94 and 92%; 4 surface, 88 and 96%; PGBE ester of 2,4-D 2, (applied 1 day after emergence of corn), 74 and 56%; ethylhexanol ester of 2,4-D (G) 2, 59 and 58%; 2,6-dichlorobenzonitrile (Casoron) 2, 91 and 57%; 3, 94 and 70%; 4, 96 and 65%; simazine 2, 99 and 93%; 3, 99 and 95%; atrazine 2, 100 and 95%; 3, 100 and 94%; atrazine (G) 2, 100 and 94%. Stand of corn was reduced 37% 50%, and 70% for Casoron at 2, 3, and 4 lb/A respectively and less than 10% for all the other treatments. Corn showed epinasty in approximately 15% of the plants where R-1607 was incorporated with the soil at rates of 4 or 6 lb/A or R-1607 (G) at 4 lb/A, and to considerable extent where treated with 2,4-D 2 lb/A early postemergence, for two weeks after treatment, after which corn was somewhat stunted. (Agronomy Department, Kentucky Agr. Exp. Sta.)

Control of weeds in bottomland corn with pre-emergence herbicides. Freeman, J. F. Corn, hybrid US523-W, was planted on alluvial soil of Ohio River bottomland in Henderson County, May 18,1960. Principal weeds were giant foxtail and wild sorghum with some redroot pigweed, burcucumber, and big-leaf morning glory. Four-row plots with treatments quadruplicated in a randomized block design were used. Herbicides were applied in 13" bands centered over the rows which were 40" apart. Spray-type herbicides were used in water spray at rate of 39 gal/A solid coverage basis and granular (G) types were spread in bands with a commercial applicator mounted on bicycle-wheel sprayer chassis. Actual rate of herbicides and spray used was 1/3 that shown for solid coverage. Incorporated (incorp.) treatments had herbicide chopped into soil 2" deep with hoe. Rainfall of ½ inch occurred the day after treatment and heavy rains later in the week. Corn came up a good stand. The number of each of several species present in a 9"-row band centered on each of the two inside plot rows was counted June 21. Treatments and percentage reduction of weeds for each, based on the untreated check which had 16 weeds/sq ft (11 giant foxtail + 2 wild sorghum + 2 broadleaf) were (rates are lb/A): Mixture CDAA and trichlorobenzyl

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chloride 3.1 + 7.9, 81%; simazine 2 and 3, 71 and 76%; atrazine 2 and 3, 61 and 74%; atrazine (G) 2, 44%; 2,4-DEP 5, 68%; fenac, sodium salt 2, (surface) and 2 (incorp.), 63 and 88%; EPTC 3 (surface), and 3 (incorp.), 79 and 82%. None of the herbicides reduced stands of corn below that of the check. Percentage of small epinastic corn plants was 20% for fenac 2 lb/A (incorp.), 10% for fenac 2 lb/A (surface) and 17% small plants for atrazine (G) 2 lb/A. For other treatments percentages ranged from 3 to 8%. (Agronomy Department-Kentucky Agr. Exp. Sta.)

Weed control in corn with spray and granular formulations of herbicides. Meggitt, W. F. Michigan 300 hybrid field corn was planted on June 2 in a Conover silt loam soil. Pre-emergence herbicide treatments were made on June 4 using the following materials and formulations: atrazine 2 lb/A as an 80% wettable powder, granular formulations at 4 and 8% on Attaclay and 10, 15, and 20% on ammonium sulfate; simazine at 2 lb/A as the 80% wettable powder, 4% on Attaclay and 8, 13, and 17% on ammonium sulfate, CDAA at 4 and 6 lb/A as the emulsified spray and as the 20% granular formulation; CDAA plus trichlorobenzyl chloride (TCBC) at 4.5 and 6 quarts/A of the emulsifiable formulation and 30 lb/A of the 20% formulation; 2,4-D at 2 and 3 lb/A as the emulsifiable propylene glycol butyl ether (PGBE) ester, 20% granular formulation of PGBE ester, granular formulations of 20% ethyl hexyl ester, 10% dimethyl amine, and 10% acid as quick-release and slow-release formulations (Diamond DM308 and DM310).

Granular formulations were applied by hand to ensure uniform distribution. Sprays were applied in water at 20 gallons per acre.

Rainfall occurred on June 5 (.15 inch), June 13 (.67), June 14 (.18), June 15 (.14), and June 17 (.94).

The major weed species present were pigweed, lambsquarters, yellow foxtail, crabgrass velvetleaf, purslane, ragweed, and quackgrass.

Atrazine in all formulations and simazine as the 80% wettable powder and the 4% granular formulation provided complete control of annual broadleaved and grass weeds throughout the entire growing season. Atrazine also reduced the stand and provided some stunting of quackgrass. Granular formulations of simazine which were greater than 4% did not provide adequate weed control.

Annual grasses were controlled by CDAA and fair to good control of both grasses and broadleaved weeds was obtained from CDAA plus TCBC.

All formulations of 2,4-D provided good control for 4 to 6 weeks after application. There were no differences in weed control results when comparing spray and granular formulations. Considerable stunting of corn was produced by 2,4-D at 3 lb/A and some stunting by granular formulations at 2 lb/A. Most of these effects were outgrown later in the season.

In the case of all granular formulations of herbicides except simazine at higher concentrations, the weed control obtained was comparable to spray formulations. (Dept. of Farm Crops, Michigan Agri. Exp. Sta.)

Effectiveness of four herbicides applied as pre-planting treatments for control of weeds in sweet corn. Sexsmith, J. J. Duplicate 8-by 28-ft plot areas of a silty clay loam irrigated soil at Lethbridge were sprayed on May 27, 1960, with EPTC at 2 and 3 lb/A. 2,3-dichloroallyl diisopropylthiolcarbamate (Avadex) at 1½ and 2 lb/A; atrazine at 1 and 2 lb/A; and a mixture containing 3.36 lb CDAA and 8.4 lb trichlorobenzyl chloride per gallon (Randox T) at 3 and 4 qt/A. All were applied at a solution rate of 34.3 gpa and the areas immediately disked in two directions. The following day 13 crops, including Seneca Golden sweet corn, were seeded across each plot. Weed control and crop injury ratings were taken on July 14 and observed at intervals up to three weeks later. Weed control estimates are given in the following table:

	EPTC	Avadex		Atrazine		Randox T	
Weed	2 lb	3 lb	1½ lb	2 lb	1 lb	2 lb	3 qt	4 qt
Wild oats-%	85	96	96	97	80+	95	80	85
Green foxtail	F-G	F-G	F	G	—	G	F	F-G
Broad-leaf	N-P	P-F	N	N	F-G	G	G	G-E

(N = nil; P = poor; F = fair; G = good; E = excellent; — = insufficient stand for rating.)

All herbicides except Randox T gave excellent control of wild oats at the higher rates, and that from Randox T could be considered acceptable. For control of green foxtail, Avadex and atrazine appeared to be only slightly better than the other materials. At best, EPTC and Avadex were unsatisfactory for control of the infestation of mixed redroot pigweed and common lambsquarters, whereas both atrazine and Randox T gave good control, with atrazine only slightly less effective. It was noted that some wild oat plants obtained considerable growth before being killed by atrazine, and in the Randox T plots a delayed germination and growth occurred. None of the treatments caused visible injury to corn up to time of tasselling. (Canada Dept. of Agriculture, Research Station, Lethbridge, Alberta.)

SORGHUM

Pre-emergence and post-emergence weed control in grain sorghum. Burnside, O. C. Hybrid RS 610 sorghum was planted in Sharpsburg silty clay loam soil at Lincoln, Nebraska, on May 12, 1960. Pre- and post-emergence herbicide applications were made on May 12 and May 31, repsectively, to triplicated square rod plots in 20 gallons of water per acre. Plots which received herbicide applications were not cultivated. Major weed species present were *Amaranthus retroflexus, Setaria* spp., *Digitaria sanguinalis,* and *Panicum dichotomiflorum.* The herbicides applied, ("T" is trichlorobenzyl chloride) and the grassy, broadleaf and sorghum yields taken September 9 are presented in the table. The weed yields were obtained by clipping weeds from 8 sq ft of row.

Treatment	Rate lb/A	Dry weight of weeds lb/A		Sorghum bu/A at 14% moisture
		Broadleaf	Grassy	
Weedy check	—	420 ab*	3380 d	29
Cultivated check (3)	—	0 a	110 a	74 a
Hand-weeded check	—	0 a	0 a	108 d
Pre-emergence (no cultivations)				
CDAA	4	40 a	1180 ab	81 abc
CDAA	6	120 a	2560 cd	74 a
CDAA granules	6	140 a	2000 bc	75 ab
CDAA+T	2.8+7	240 a	20 a	108 d
CDAA+T granules	2.8+7	650 abcd	20 a	107 d
CDAA+T	4.2+10.5	320 ab	0 a	110 d
CDAA+2,4-D	4+1	560 abcd	1100 ab	73 a
Propazine	2	870 abcd	0 a	94 bcd
Propazine	4	900 abcd	0 a	95 cd
Propazine	8	660 abcd	0 a	104 d
Atrazine	2	1010 abcd	0 a	97 cd
Atrazine	4	430 abc	0 a	106 d
Post-emergence (no cultivations)				
2,4-D isopropyl ester	1/3	1430 cd	460 a	68 a
Atrazine	2	1560 d	0 a	75 a
Propazine	2	3160	0 a	83 abc
Propazine	4	1330 bcd	0 a	84 abc

* Numbers accompanied by the same letter do not differ significantly at the 5% level using Duncan's multiple range tests.

Excessive rainfall prevented cultivation of check plots during the first month following planting. Pre-emergence applications of CDAA+T, atrazine, and propazine resulted in excellent weed control during the

monthly following herbicide application, and sorghum yields from these chemically treated, uncultivated plots were not significantly different from the hand-weeded checks. Late-emerging grasses such as *Panicum dichotomiflorum* became established in the atrazine and propazine plots. None of the post-emergence applications did an efficient job of controlling grassy species, and this was reflected in reduced sorghum yields. This experiment has shown the feasibility of controlling weeds with pre-emergence herbicides rather than cultivation, as treated-sorghum yields were equal to that of hand-weeded checks. (Contribution of the Dept. of Agronomy, Univ. of Nebraska, Lincoln. Paper No. 1085A, Journal Series.)

Weed control in grain sorghum with herbicides. Freeman, J. F. Hybrid grain sorghum (PAG 425-S) seed was drilled 1-1½" deep in Burgin silt loam at Lexington June 16, 1960. Two-row plots (40" rows) with an untreated check row between plots and as outside border were used with treatments in a randomized block design and 3 replications. After planting pre-emergence treatments were applied in 13 1/3"-bands centered over rows.

Post-emergence treatments were applied when sorghum was 6" or 12" high. Spray herbicides were applied in water, 39 gal/A overall basis, and granular (G) formulations were applied at proper rate with commercial-type applicator mounted on bicycle-wheel sprayer chassis. Actual rate of herbicide used in each case was 1/3 that of the overall rate shown. Rains amounting to 1.5" fell the day following pre-emergence treatments and more than 7" fell during the week following emergence of the sorghum inundating some of the plots for several hours. Weeds (redroot pigweed, crabgrass, goosegrass, and giant foxtail) were counted in a 9" x 20'-band centered over each row during 5th week after emergence of crop. Treatments are listed with the percentage reduction of weeds being shown for each, based on the average number present on its adjacent check rows. The average number of weeds for all check rows was 5.6/sq ft (4.1 broadleafs + 1.5 grasses). Pre-emergence treatments: propazine, 2, 3, and 4 lb/A, 73, 93, and 97% reduction respectively; 2,4-bis(isopropylamino-6-methylmercapto-*s*-triazine (Prometryne) (G34161), 2, 3, and 4 lb/A, 86, 99, and 97%; 2,6-dichlorobenzonitrile (Casoron), 2, 3, and 4 lb/A, 78, 93, and 92%; Casoron (G), 2, 3, and 4 lb/A, 97, 98 and 98%. Post-emergence treatments (when sorghum 6" tall): atrazine, 2, 3 and 4 lb/A, 60, 89 and 76%; alkanolamine salt of 2,4-D, 0.25 and 0.50 lb/A, 42 and 50%; (when sorghum 12" tall) 2,4-D, 0.25 and 0.50 lb/A, 35 and 25%; cultivated check 80%. Crop-stand reductions, based on adjacent untreated check rows, were severe for Casoron and Casoron (G) at all rates and for G34161 at 3 and 4 lb/A; none or slight for other treatments. (Agronomy Department, Kentucky Agr. Exp. Sta.).

Herbicides for weed control in grain sorghum. Robison, R. G., Thompson, R. L., Nelson, W. W., and Johnson, R. A. Cultivation alone cannot be depended upon to control weeds in grain sorghum in Minnesota so CDAA at 4 lb/A pre-emergence and, if needed, an amine salt of 2,4-D at ¼-½ lb/A post-emergence are recommended. CDAA in 7 trials in 1957-59 increased yields in all trials and gave an average increase of 14 bu/A, although injury to sorghum sometimes occurred when emergence was delayed by cold weather.

Trials in 1960 at Rosemount, Morris, Lamberton, and Waseca indicated that CDAA at 3.15 lb/A + trichlorobenzyl chloride at 7.9 lb/A gave more control of non-grass weeds and less control of grass weeds than did CDAA at 4 lb/A, but differences were small and not consistent. At Morris, both treatments were most effective when applied one week after planting; whereas at Waseca, applications at planting time gave best control. These Waseca applications at planting time were the only ones that injured sorghum in 1960 trials. 1960 yields have not yet been determined.

Atrazine, propazine, or simazine at 2 lb/A gave no injury when applied either pre- or post-emergence. Simazine in previous trials has sometimes injured sorghum enough to that yield increases have not always been obtained. Propazine pre-emergence gave good weed control at the 4 locations and post-emergence at Rosemount (not tried post-emergence elsewhere). Atrazine pre-emergence gave good control at Morris, Waseca, and Lamberton; atrazine post-emergence gave good control at Morris, Lamberton, and Rosemount but poor at Waseca. Simazine was less effective than atrazine. Propazine was also tried at 3 lb/A pre-emergence, and excellent weed control and no sorghum injury resulted.

At Rosemount, mixtures and combination treatments were studied. CDAA, 4 lb/A pre-emergence + atrazine, propazine, or simazine, 2 lb/A at 3-inch stage were successful in combination treatments. CDAA, 2 lb/A + propazine, 2 lb/A pre-emergence was a successful mixture.

Amiben at 3 or 4 lb/A generally gave good weed control but injured sorghum. 2-chloro-4-methylamino-6-isopropylamino-*s*-triazine at 2 lb/A did not control weeds. (Contribution from the Dept. of Agronomy and Plant Genetics, Univ. of Minnesota, St. Paul; West Central Station, Morris; Southwest Station, Lamberton; and Southern Station, Waseca. Paper No. 4498, Sci. Jour. Series, Minnesota Agric. Expt. Sta.)

Effect of 2,4-D on sorghum varieties. Wiese, A. F. and Rea, H. E. In an effort to determine if there were differences in tolerance to 2,4-D, various sorghum varieties or hybrids were treated with 2 lb/A of butoxy ethanol ester of 2,4-D when the crop was 5 inches tall or in the pre-boot stage when the young sorghum head was 2 inches above the soil line. Plots of each variety were left untreated. A plot was one-30 inch row 60 ft long. The treatments were replicated 4 times. The plots were irrigated, and the average yield of the untreated variety plots was 6300 lb/A. The most injury usually occurred when the 2,4-D was applied to 5-inch sorghum. Midland variety was the only exception and its yield was reduced 7 percent at the small stage and 18 percent at the larger stage. Considering the small stage only, the percent yield reduction for each variety or hybrid was RS 610, 0; Texas 608, 3; RS 650, 4; Texas 611, 6; Midland, 7; DeKalb F62a, 10; Combine kafir 60, 13; Amak R 12, 16; Texas 660, 17; Redbine 66, 19; Wheatland, 36; and Combine shallu, 37. Flowering date, heads per acre and plant height were not closely associated with the yield reductions. (Contribution of the Southwestern Great Plains Field Station, Bushland, Texas, Texas Agr. Exp. Sta. and USDA cooperating. Approved as TAES T.A. 3645.)

SOYBEANS

Herbicides on soybeans. Bondarenko, D. D., Ascheman, R. E., Stroube, E. W. and Smith, W. D. Harosoy soybeans were planted in 40-inch rows in Brookston silty clay loam at the Western Substation on May 16, 1960. Blackhawk soybeans were planted in 42-inch rows in Hoytville silty clay loam at the Northwestern Substation on May 24. Lincoln x Monroe soybeans were planted in 42-inch rows in Miami-Brookston silty clay loam at Columbus on June 7. The plots had a natural infestation of Pennsylvania smartweed, wild mustard and Venice mallow at Western; redroot pigweed, lambsquarters, velvetleaf and common ragweed at Northwest; redroot pigweed, green foxtail and crabgrass at Columbus. All liquid formulations were applied in 40 gpa water (over-all rate) in 20-22-inch bands. Granular formulations (at Columbus only) were applied in 14-inch bands. Triplicate 4-row plots were treated by the following herbicides (rates in lb/A).

Pre-emergence, applied May 19 at Western, May 24 at Northwest and June 8 at Columbus: amiben at 3; amiben + CIPC at 2 + 2 and 3 + 3; sodium salt of NPA at 4; CDAA at 4; CDAA + CIPC at 3 + 2; CDAA + alkanolamine salts of DNBP at 2 + 2 and 3 + 3; CIPC + NPA at 2 + 2 and 3 + 3; CIPC at 6 and 8 at Western and Northwest, 7 at Columbus; and CIPC + DNBP at 2 + 2 and

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3 + 3. At Columbus granular formulations of amiben, amiben + CIPC, NPA, CDAA + CIPC, CIPC + NPA, and CIPC were applied at the same rates as the corresponding liquid formulations mentioned above. Also applied at Columbus were CDAA + PCP granular at 3 + 5 and 3 + 10 and DNBP + Zytron [*O*-(2,4-dichlorophenyl) *O*-methyl isopropylphosphoramidiothioate] liquid at 2 + 2 and 3 + 3.

First trifoliate stage, at Columbus: DNBP liquid at 2¼ and 3.

The weed control results following were on the basis of good=90% to 100% reduction in weed populations, fair = 70% to 89%, poor = less than 70%.

Results: amiben and amiben + CIPC good at all rates at all locations; NPA good at Northwest, fair at Columbus, poor at Western; CDAA fair to poor on the broadleaf weeds, good on the annual grasses; CDAA + CIPC good on smartweed and wild mustard at Western, fair on Venice mallow at Western, fair at Northwest and Columbus; CDAA + DNBP fair at Northwest and Columbus, poor at Western; CIPC + NPA good at all locations except fair on Venice mallow at Western; CIPC good at Western, fair at Northwest and Columbus; CIPC + DNBP fair to good; CDAA + PCP granular (at Columbus) good; DNBP + Zytron (at Columbus) fair at 3 + 3, poor at 2 + 2. The granular formulations, applied only at Columbus, gave results similar to the corresponding liquid formulations. DNBP post-emergence, applied only at Columbus, gave good weed control.

At the Western Substation, where smartweed was a serious problem, the yield of the soybean plots treated by amiben, amiben + CIPC, CDAA + CIPC, CIPC + NPA, CIPC, and CIPC + DNBP averaged 30.9 bu/A with little or no difference between treatments, the check plots, 21.5 bu/A; all plots cultivated twice. The other treated plots, which were as densely infested with weeds as the check plots, were not harvested. Soybean yields at the other locations were not recorded.

DNBP post-emergence (at Columbus) at 2¼ and 3 damaged the soybeans slightly. No other treated plot showed herbicide damage at harvest. (The Ohio Agr. Exp. Sta.)

Pre-emergence weed control in soybeans. Burnside, O. C. and Lipke, W. G. Ford soybeans were planted in a Sharpsburg silty clay at Lincoln, Nebraska, on May 13, 1960. Pre-emergence herbicide applications were made on May 14 to triplicated square rod plots in 20 gallons of water per acre. Herbicide-treated plots were not cultivated. Major weeds present were *Setaria* spp., *Amaranthus retroflexus*, *Digitaria sanguinalis*, and *Panicum dichotomiflorum*. The herbicides applied, and the grassy, broadleaf and soybean yields harvested on October 17 are given in the table. The weed yields were obtained by clipping weeds from 8 square feet between the soybean rows.

Treatment	Rate lb/A	Dry weight of weeds in lb/A		Soybeans bu/A
		Grassy	Broadleaf	
Check—hand-weeded	—	0 a*	0 a	33.4
Check—three cultivations	—	0 a	0 a	23.1 c
Check—weedy	—	1070 c	4930 e	11.5
Pre-emergence applications (not cultivated)				
Amiben	2	430 b	350 ab	28.3 de
Amiben	4	80 a	0 a	27.9 d
Amiben	8	0 a	0 a	29.6 e
Amiben granules	4	340 b	160 a	27.3 d
CDAA	4	120 a	4260 de	20.4 b
CDAA	6	110 a	3220	23.6 c
CDAA granules	6	50 a	4540 de	19.8 b
NPA	4	2680	1480 c	19.2 b
NPA	6	1150 c	910 bc	22.9 c
NPA granules	4	2030	4030 d	17.7 a
CDAA + IPC	3+2	360 b	4750 de	19.0 ab
DNBP	8	540 b	1450 c	22.5 c

* Numbers accompanied by the same letter do not differ significantly at the 5 percent level using Duncan's multiple range tests.

Excessive rainfall prevented cultivation of check plots during the first month following planting. Amiben was the outstanding selective herbicide in this experiment. CDAA did a good job of controlling grassy weeds but broadleaf weeds markedly reduced soybean yields. Granular applications of CDAA and NPA were less effective than similar spray applications in controlling broadleaf weeds, while granular applications of amiben were less effective than spray applications in controlling grassy weeds. This experiment has shown the feasibility of controlling weeds in soybeans the entire season without cultivation with pre-emergence applications of amiben. Cultivation would be necessary in conjunction with the other herbicides used. Earlier amiben treatments on sweetclover plots adjoining this experiment have shown the need of rainfall soon after pre-emergence application in order to get good weed control. (Contribution of the Dept. of Agronomy, Univ. of Nebraska, Lincoln. Paper No. 1084A, Journal Series.)

Control of weeds in soybeans with pre-emergence herbicides. Freeman, J. F. Soybeans (Clark variety) were planted in Burgin silt loam soil at Lexington June 8, 1960. Two-row plots 25′ in length with an untreated check row between plots and as a border for outside plots were used with treatments in randomized block design with 4 replications. Treatments were applied June 9 in 13 1/3-inch bands centered over rows 40″ apart. Spray-herbicides were applied in water 39 gal/A-overall basis, and granular (G) herbicides were applied with a commercial type applicator mounted on bicycle-wheel sprayer chassis. Actual rate of herbicides used in the band was ⅓ that of the over-all rate indicated. Rains of ½″ fell 2 days after treatment and of about 10″ in the 2 weeks following crop emergence, some plots being inundated by water for several hours at a time. Weeds (redroot pigweed, crabgrass, goosegrass, giant foxtail) were counted in a 9″ x 20′-band centered over each row during 5th week following crop emregence. Treatments are listed (rates in lb/A) with the percentage reduction in weed numbers, based on the average number present on the adjacent untreated rows, being shown for each. The mean for all untreated rows was 12.3/sq ft (10.3 broadleafs + 2 grasses). Amiben 3 and 4 lb/A, 92 and 95% reduction respectively; amiben (G), 3 and 4, 95 and 95% sodium salt of NPA, 4 and NPA (G) 4, 69 and 50%; CDAA 4 and CDAA (G) 4, 36 and 34%; propylethyl-*n*-butylthiolcarbamate (R-2061) 2, 4, and 6, 62, 75, and 80%; EPTC 2 incorporated with soil by chopping 1″ deep with hoe following treatment, 76%; prometone 1, 1½ and 2, 88, 97 and 98%; 2,4-bis(isopropylamino)-6-methylmercapto-*s*-triazine (G-34161), 2, 4, and 6, 96, 100, and 99%; 2,6-dichlorobenzonitrile (Casoron) 2, 3 and 4, 90, 94, and 91%; sodium salt of PCP 15, 96%; DNBP (G) 6, 78%; cultivated check, 91%; and uncultivated check, 0%. Crop injury ratings of July 14 indicated severe reduction in stand and some reduction in growth for prometone at 1½ and 2 lb/A, G-34161 at 4 and 6 lb/A; severe reduction in stand for Casoron at all rates; and none or slight injury for other herbicide treatments. (Agronomy Dept., Kentucky Agr. Ex. Sta.)

Pre-emergence weed control in soybeans. Peters, E. J. and Davis, F. S. Clark soybeans were planted on Putnam silt loam on May 17, 1960, and sprayed with pre-emergence herbicides in water at 40 gal/A. Materials and rates in lb/A were as follows: 20 sodium salt of PCP; 2, 3, and 4, amiben; 4, 8, and 12, ethyl-*O*-nitrophenyl sulfide (CP-13842); 10, 15, and 20 *O*-(2,4-dichloropenyl) *O*-methyl isopropylphosphoramidothioate (DMPA); mixture of 5 DMPA and 3 DNBP; and of 10 DMPA and 3 DNBP. Granular materials were applied at the following rates per acre of active ingredients: 15 lb of DMPA, 3 lb amiben and a mixture of 10 lb DMPA and 3 lb DNBP.

In a second experiment, planted on May 24, the following pre-emergence applications and rates in lb/A were applied in water at 40 gal/A: 20, sodium salt of (PCP); 4, CDAA; and 4, 6, 8, of *sec*-butynyl *m*-chlorocarbanilate (CP-18799). Mixtures used were: 3

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CDAA plus 2 CIPC; 3 CIPC and 3 CDAA plus 5, 10, or 15 PCP. Granular materials used were 20 sodium salt of PCP and a mixture of 3 CDAA and 10 PCP.

Weeds present were *Echinochloa crusgalli* (L.) Beauv., *Panicum dichotomiflorum* Michx., and *Ambrosia artemisiifolia* L. In the first experiment, amiben at 3 and 4 lb/A controlled all weeds for about 8 weeks and the sodium salt of PCP was slightly less effective. CP-13842 at 8 and 12 lb/A and DMPA at 10, 15, and 20 lb/A nearly eliminated grasses but failed to control broadleaved weeds. The mixtures of DMPA and DNBP controlled all annual weeds present. Materials applied as granules were equal to those applied as liquids.

In the second experiment virtually no weed control was obtained with CDAA at 4 lb/A but the addition of CIPC to lower rates of CDAA controlled all weed grasses. These mixtures failed to control *Ambrosia artemisiifolia*. The addition of PCP to CDAA did not increase weed control. All rates of CP-18799 gave nearly 100 percent grass control but did not control the broadleaved weeds. Granular materials did not control weeds as well as sprays, perhaps due to low rainfall after application. The sodium salt of PCP at 20 lb/A controlled both broadleaved weeds and grasses but it was somewhat less effective on grasses than some of the other materials. No injury to soybeans was observed with any of the materials. (Cooperative contribution of the Crops Research Division, Agr. Res. Serv., U. S. D. A. and Missouri Agr. Exp. Sta.)

SMALL GRAINS

Effect of simazine carry-over on oat yields. Behrens, R., and Thompson, R. L. Simazine at 0, 2, 4 and 6 lb/A was applied in pre-emergence band and post-emergence overall applications to corn planted on June 8, 1958 at Morris, Minnesota. Annual rainfall was 17 inches for 1958 and 18 inches for 1959. Oats was sown on this plot area in the spring of 1959. Injury to oats was evident in all plots treated with simazine. Where band applications were used, the injury was restricted to the band. Harvest quadrats were taken perpendicular to bands to insure proportional sampling of the treated band and intervening areas. Seed yields of oats were 58, 52, 50, and 53 bu./A from plots treated with simazine band applications of 0, 2, 4, and 6 lb/A, respectively. These differences were not significant. Seed yields of oats were 58, 54, 33, and 13 bu./A from plots treated with overall simazine applications of 0, 2, 4 and 6 lb/A, respectively. Yield reductions were significant for the 4 and 6 lb/A overall applications. Oats was sown on the plot area in the spring of 1960, also. A slight stunting of the oats which soon disappeared was observed at the 2 lb/A rate of simazine. Slight injury at the 4 lb/A simazine rate was still evident at the boot stage. Simazine applied in 1958 at 6 lb/A reduced the oat stand 50 percent or more during the 1960 growing season. (Contribution from the Dept. of Agronomy and Plant Genetics, and the West Central Exp. Sta., Univ. of Minnesota, St. Paul. Paper No. 4505 Sci. Jour. Series Minnesota Agr. Expt. Sta.)

Differential injury to foliage of wheat, barley and wild oats caused by volatility of 2,3-dichloroallyl diisopropyl thiolcarbamate (Avadex) from different types of treated soil in a closed chamber. Corns, Wm. G. In 1959 plants grown in the greenhouse in sterilized sandy soil, grey wooded soil and black soil, treated with equal amounts of incorporated Avadex, ranked in that decreasing order of injury from the chemical. During extension of this study in a growth chamber, difficulties apparently due to volatility of Avadex, became evident. To explore this problem, Montcalm barley, Thatcher wheat, and wild oats were seeded in untreated soil in small boxes, placed adjacent to treated sterilized soil of three types in separate plastic tents approx. 15" x 15" x 14". Within each tent were 2 treated boxes of one of the soils (2.3 lb/A of Avadex per treated box) and 4 untreated boxes of sandy soil for comparison with the controls. The experiments were repeated twice and the mean relative lengths of shoots in untreated sand one week after commencement of the tests are shown in the table.

	Montcalm		Thatcher		Wild Oats	
	1	2	1	2	1	2
Check in sand	100	100	100	100	100	100
Beside treated sand	86	90	35	47	26	33
Beside treated gray wooded	85	94	68	71	29	33
Beside treated black	91	95	96	91	42	45

The data show selectivity to vapors of Avadex on foliage of the different species, and less volatility (greater retention and/or inactivation) by black loam soil. (Division of Crop Ecology, Dept of Plant Science, Univ. of Alberta.)

Barban (Carbyne) and 2,6-dichlorobenzonitrile (CP 5996) as post-emergence treatments for control of wild oats in wheat (seeded infestation). Dryden, R. D. Two tests were established on a relatively weed-free area of summerfallow on May 12, 1960. Wild oats were seeded across the plot area. Two formulations of barban, Carbyne and 4 S-847-MN (F), and CP 5996 were applied at four rates and three stages of wild oat development. Two types of spray nozzles were used (1) fan, 650067; and (2) hollow cone, X-4. Applications were made in water at 5 gal/A with a spray pressure of 40 psi, at approximately the 1½-2, 2½-3, and 3½-4 leaf stages of the wild oats on June 3, June 6, and June 10.

The control of wild oats with Carbyne was most effective at Stage 1, using fan nozzles; 40, 68, and 79% at ¼, ½, and 1 lb/A respectively, producing increases in wheat yields at 2.3, 3.3 and 0.6 bu/A. The untreated plots produced 28.5 bu/A and contained 77 wild oat tillers per square yard. CP 5996 resulted in maximum controls of 16% at Stage 2 (2 lb/A), and 18% at Stage 3 (3 lb/A). At Stage 2 the yield increase was 4.9 bu/A and at Stage 3, 2.5 bu/A, (neither significant).

Cone nozzles produced significant increases in yields of wheat at all stages with S-847-MN(F), and at Stage 1 using Carbyne. The check plots averaged 66 wild oat tillers per square yard and the check yield was 35.0 bu/A. Barban (Carbyne) at ¼, ½, and 1 lb/A reduced the number of tillers by 6, 34, and 73% and increased the yields of wheat by 4.3, 8.0, and 6.4 bu/A.

S-847-MN(F) (Stage 1) at ¼, ½ and 1 lb/A gave controls of 52, 37, and 46%, with yield increases of 10.5, 5.2, and 7.6 bu/A. At Stages 2 and 3 S-847-MN(F) increases in wheat yields varied from 4.2 to 5.9 bu/A. (Experimental Farm, Research Branch, Brandon, Manitoba.)

Pre-planting application of 2,3-dichloroallyl diisopropylthiolcarbamate (Avadex) for control of wild oats in wheat, barley and flax (seeded infestation). Dryden, R. D. Avadex was applied at 0, 1, 1.5, 2, and 2.5 lb/A in 5 and 10 gal/A of water at 30 psi on May 12, 1960, on a relatively weed-free area of summerfallow varying in texture from medium to light. Treatments were incorporated with a double disc. Tests of wheat, barley and flax, with wild oats seeded across the plots, were then established. The wheat was on a clay loam, barley on a loam, and flax on a sandy loam soil.

Wild oat control appeared to be influenced by soil texture since the highest control occurred in the barley and flax tests. This was probably due to greater retention of chemical in the lighter soil, as a result of better compaction. Applications of Avadex in different volumes of water did not affect the results generally.

On the wheat test, the treatments reduced the number of wild oat tillers by 26 to 63%, but did not prevent the production of high yields of wild oat seed (140-340

lb/A). In addition, the yields of wheat were reduced 11-20 bu/A, depending on the rate of application.

Wild oat control in barley varied from 82 to 91% and produced yield increases of 3 to 7 bu/A, compared with a check yield of 44.7 bu, containing 55 wild oat tillers per square yard. On a lighter infestation of wild oats (25 tillers per square yard, check yield, 54.2 bu/A) 1 lb/A resulted in an increase of 0.4 bu, while 2 lb/A decreased the yield of barley by 11.4 bu/A. Control in flax was generally in the 85-96% range and resulted in significant increases in yield of 4.5 to 8.2 bu/A in five of the six treatments. (Experimental Farm, Research Branch, Brandon.)

Barban Carbyne) and 2,6-dichlorobenzonitrile-CP5996 for selective control of wild oats in wheat. Gorby, B. J. Spraying was done with cone nozzles on a Jari power sprayer. Plots were selected on a naturally infested wild oat area of a field seeded to wheat on the Goodlands Research Project Farm. Barban applications of ¼ and ¾ lb/A with 5 gal/A water were made at 40 lb psi at the 2 and the 3½ leaf stages of wild oats on the 8th and 16th June. In addition, at the second stage 2,4-D at 5 oz/A was applied with each rate of barban on adjacent plots. CP 5996, at 3 lb/A, was applied without 2,4-D at the 3½ leaf stage only. Evaluation of plots was based on replicated square yard samples removed before swathing time.

The check population was 298 wild oat tillers per square yard. Barban at ¼ lb/A reduced wild oat tillers 92% at Stage 1 and 69% at Stage 2; ¾ lb/A, 53% at Stage 1 and 69% at Stage 2. Wheat averaged 8.1 bu/A over the check (21.6 bu) where barban was applied at ¼ lb/A, Stage 1. Barban at ¼ and ¾ lb/A, with 2,4-D at Stage 2, reduced wild oat tillers by 25 and 27 %. Malformations appeared in wheat in the 2,4-D treatments. CP 5996 failed to reduce wild oat tiller population. (Research Branch Experimental Farm, Brandon.)

Barban (Carbyne) and 2,6-dichlorobenzonitrile (CP 5996) for the control of wild oats in barley (seeded infestation. Dryden, R. D. On May 12, 1960, a test using Parkland barley was established on summerfallow with wild oats seeded across the plot area. Barban and CP 5996 were applied in 5 gal/A of water with X-4 cone nozzles at a spray pressure of 40 psi, at the 1½-2, 2½-3 and 3½-4 leaf stages of wild oats on June 3, June 6, and June 10.

Numbers of wild oat tillers were reduced most effectively from the untreated 44 wild oat tillers per square yard with barban at Stage 2, 25, 39, and 41% at ¼, ½, and 1 lb/A, respectively. Barley yield increases from these rates were 6.4, 0.7 and 4.2 bu/A (check yield 53.0 bu/A.) At Stage 1, barban produced controls of 15% and 27% at ¼ and ½ lb/A, with corresponding yield increases of 0.5 and −2.4 bu/A. CP 5996 at Stage 1 resulted in controls of 12% and 2% at 2 and 3 lb/A, producing yield increases of 2.8 and 6.0 bu/A. The checks produced 43.1 bu/A and 41 wild oat tillers per square yard. At Stage 3, wild oat tillers were reduced by 22% and 24% at 2 and 4 lb/A. The effect of CP 5996 on yields of barley at Stage 3 was slight. Yield increases were not significantly different in this test. (Experimental Farm, Research Branch, Brandon, Manitoba.)

The effect of fertilizers on the degree of injury to wheat by barban (Carbyne). McCurdy, E. V. Barban was applied with a field sprayer at ¾ lb/A to two fields of wheat, one sown on summerfallow and the other on stubble. Half of each field was fertilized, the summerfallow with 50 pounds 11-40-0 and the stubble with 100 pounds 16-20-0. Crop injury resulting from the application of barban was evident throughout the growing season, but this was much less apparent on the fertilized area than on the check. Wild oat control was excellent. Paired square yard samples taken from the unfertilized summerfallow crop indicated a decrease in yield from 23.5 bu/A to 19.7, whereas a marked increase in yield of from 26.3 to 36.6 bu/A occurred on the fertilized area, partly because of the decrease in injury but also because of the complete elimination of wild oats. Barban had no effect on the yield of the stubble crop. The unfertilized, untreated area yielded 16.5 bu/A and the treated area 16.8 bu/A. Both treated and untreated fertilized crops yield 25.8 bu/A. (Contributed by the Experimental Farm, Indian Head, Saskatchewan)

2,3-Dichloroallyl diisopropylthiolcarbamate (Avadex)* for wild oat control in wheat, 1960. Selleck, G. W. Avadex was applied May 16, 1960 at Spalding, Sask., at from 1 to 2 lb/A in 4.2 gal/A at 30 psi and 8.4 gal/A at 13 psi on 1-acre summerfallow plots on loam soil. Untreated strips were adjacent to each treated plot. Incorporation was done with a cultivator followed by a harrow, compared with double-disking the same day of application. The area was seeded to Thatcher wheat and harrowed 6 days after application. The estimated percentage wild oat control (as verified by quadrat counts) and percentage wheat thinning, August, 1960, are presented below.

Rate	Water	Cultivated and harrowed		Double-disked	
lb/A	gal/A	Control	Thinning	Control	Thinning
1.00	8.4	95	0	95	0
1.25	8.4	95	10	95	10
1.50	8.4	99	15	99	15
1.50	4.2	99	20	99	20
1.75	8.4	99	30	95	30
2.00	8.4	99	40	95	40

Control was less effective in wet depressions as a result of deep and inefficient incorporation. The wheat was thinned from 90 to 99% in isolated boom-widths throughout all of the treated plots. This is believed to be a mixing problem. The sprayer was delivering maximum pressure, thus preventing any bypass of material to the tank. Another plot was treated at 1½ lb/A in 4 gal water and incorporated with a harrow the same day. 95% wild oat control was obtained with 10% thinning in wheat. The wild oat population in check plots reached a maximum of 288/sq yd. (Contribution from the Monsanto Chemical Company.)

* Trademark of Monsanto Chemical Company, Reg. U. S. Pat. Off.

2,3-Dichloroallyl diisopropylthiolcarbamate (Avadex) for wild oat control in barley, 1960. Selleck, G. W. Avadex was applied at Nipawin, Sask., June 1, 1960, with a farm sprayer at rates between 1 and 2 lb/A in 8.8 gal water at 30 lb psi in 15 to 20 mph winds to 1-acre plots on sandy loam soil on summerfallow. Check strips were located adjacent to treated plots. Wild oats were in the 1 to 2½ leaf stages with densities up to 4000/sq yd. Half of the plots were cultivated and harrowed the same day of application. The remainder were diskered, harrowed and packed the following day, and the whole area seeded to Parkland barley and Altaswede red clover. The soil was very moist at the time of application, requiring rod-weeding on cultivated plots to kill emerged wild oats. The estimated percentage control of wild oats (verified by quadrat counts) and percentage thinning of barley August, 1960, are presented below.

Rate	Diskered and harrowed		Cultivated and rod-weeded	
lb/A	Control	Damage	Control	Damage
1.00	70	0	65	0
1.25	85	0	85	0
1.50	95	10	95	0
1.75	99	15	95	0
2.00	99+	30	95	10

No significant difference in wild oat control or crop thinning was evident where incorporation by a cultivator and rod weeder was followed by the disker and harrow the following day. Less effective control was obtained in moist potholes where incorporation was poor. Red clover was not adversely affected, flourishing in bare

areas where high concentrations of spray killed the barley. (Contribution from the Monsanto Chemical Company.)

2,3-Dichloroallyl diisopropylthiolcarbamate (Avadex) for wild oat control in grain crops, 1960. Selleck, G. W. Avadex at from 1 to 2.3 lb/A in 6.25 gal water at 25 psi were made May 2 at Kindersley, Sask., to heavy clay soil on 1-acre plots. Check strips were alternated with treated plots. The plots were incorporated the same day to a depth of 4 to 5 in with a one-way and harrowed twice. Parkland barley and Selkirk wheat were seeded 9 days later. The estimated percent control of wild oats and thinning of crops August, 1960 are presented in the following table. The wild oat population in check strips reached a maximum of 1,010/sq yd.

Rate	Pct wild oat control		Pct thinning	
lb/A	Wheat	Barley	Wheat	Barley
1.00	95	95	15	25
1.25	95	95	20	35
1.50	95	95	50	50
1.75	95	95	60	72
2.00	90	95	60	75
2.30	90	90	90	85

The soil was extremely loose, resulting in deeper than normal planting. In some spots, crop seedlings emerged from a depth of 4 in. Germination was poor also on check plots. Durum wheat was sown in a 4-acre plot treated with Avadex at 1.6 lb/A and incorporated as above. Wild oats were controlled 95% and wheat thinned by 50%. (Contribution from the Monsanto Chemical Company.)

Aerial applications of 2,3-dichloroallyl diisopropylthiolcarbamate (Avadex) for wild oat control, 1960. Selleck, G. W. Pre-seeding applications of Avadex were applied with a Cessna 172 aircraft at rates from 1 to 2.2 lb/A in 1 gal of diesel fuel at 35 to 40 psi on 1-acre plots in silty clay loam soil at Meskinaw, Sask., May 27, 1960. The 1.90 and 2.16 lb/A rates were applied with 2 and 4 gal/A of diesel fuel, respectively. Treated plots were alternated with check strips. One-third of the plots were incorporated the same day with a disker to a depth of 4 in and 1/3 with a cultivator to a depth of 6 to 8 in. One-third were incorporated with a disker after four days. One area was seeded with a disker to Selkirk wheat two weeks after application, and the other was diskered and seeded with a drill to Argentine rapeseed 4 days after application. The estimated percentage wild oat control (verified by spot quadrat counts) August, 1960 is presented in the following table. Wild oats were absent in check plots adjecent to the 2.16 lb/A rate in the diskered treatment on rapeseed.

	Wheat		Rapeseed		
Rate lb/A	Diskered and packed	Cultivated and harrowed	Diskered and packed	Cultivated and harrowed	Diskered twice after 4 days
0.96	70	50	0	50	0
1.20	85	85	70	85	85
1.44	75	70	50	75	85
1.68	85	85	80	75	90
1.90	90	70	75	90	80
2.16	90	80	—	80	90

Rapeseed was not adversely affected by any of the treatments. The stand of wheat was thinned by 10% at the 2.16 lb/A rate but was compensated by better-filled heads. (Contribution from the Monsanto Chemical Company.)

Wild oat control in durum wheat with 2,3-dichloroallyl diisopropylthiolcarbamate (Avadex) in North Dakota, 1960. Selleck, G. W. and Althaus, R. E. Pre-seeding applications of Avadex were applied with farm sprayers at rates from 1 to 2 lb/A to plots of at least 1 acre on summerfallow and second-crop land on soil of loam texture. Details of the applications are presented in Table 1.

Table 1.

	Leeds	Rolette	Devils Lake
Variety treated	Lakota	Langdon	Lakota
Volume, gal/A	3	4.5	9.4
Pressure, psi	30	40	30
Time of incorporation	next morning	same day	same day
Incorporation depth, in	3-4	4	3-4
Method of incorporation	hoe drill vs disk + hoe drill	cultivator vs harrow	cultivator
Date of application	May 2	May 2	May 4

The results are presented in Table 2.

Table 2.

	Pct control			Pct thinning			Devils Lake	
Rate lb/A	Leeds	Rolette	Devils Lake	Leeds	Rolette	Devils Lake	Yield bu/A	Pct dockage
0.00	0	0	0	0	0	0	18.3	3
1.00	95	94	—	0	0	—	—	—
1.25	94	95	75	0	0	0	24.3	2
1.50	95	96	85	0	10	10	21.8	2
1.75	95	96	90	10	5	15	25.3	1½
2.00	95	96	—	10	15	—	—	—

There was no significant difference in wild oat control or crop thinning as a result of incorporation with implements as reported above. Equivalent wild oat control was obtained on an additional plot at 2 lb/A at Rolette when incorporation was delayed 1 day. The fact that durum wheat was not injured in this plot suggests a loss of Avadex by evaporation. The incorporation in these trials is considered to be too deep for best results. (Contribution from the Monsanto Chemical Company.)

2,3-Dichloroallyl diisopropylthiolcarbamate Avadex for wild oat control in durum wheat in North Dakota, 1060. Selleck, G. W. and Althaus, R. E. Pre-seeding applications of Avadex were made with field sprayers at rates from 1 to 1.75 lb/A at 40 psi in 10 to 13 gal water on plots of at least 2.5 acres on loam soil. Check strips were adjacent to treated plots. Incorporation was done the same day at McVille on summerfallow and the next morning at Langdon on second crop land with implements as shown below. Varieties Dakota and Century were sown at McVille and Langdon, respectively, the following day. The estimated per cent control of wild oats and thinning of wheat, July, 1960, are presented in the following table.

	Pct. control				Pct. thinning			
	McVille		Langdon		McVille		Langdon	
Rate lb/A	Tandem disk	Harrow	Harrow	Cultivator + harrow	Tandem disk	Harrow	Harrow	Cultivator + harrow
1.00	95	95	—	—	0	0	—	—
1.25	95	95	95	99	0	0	0	0
1.50	95	95	95	99	15	10	15	15
1.75	95	90	97	95	20	20	12	15

The wild oat population at McVille and Langdon reached 102 and 216/sq yd respectively. At Langdon, poor wild oat control was obtained in a depression as a result of deep incorporation in wet soil. Wheat was killed out in portions of rows as a result of applications to a cultivated surface. The leveling action of the incorporation had the effect of increasing the dosage in the furrows and decreasing it on the ridges. An additional application of 2 lb/A was made by air at Langdon. Wild oats were controlled 75% and wheat thinned 25%. (Contribution from Monsanto Chemical Company.)

2,3-Dichloroallyl diisopropylthiolcarbamate (Avadex) in spring wheat in North Dakota, 1960. Selleck, G. W. and Althaus, R. E. Pre-seeding applications of Avadex

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were made at from 1 to 2 lb/A with farm sprayers at 35 to 40 psi in 7.5 to 10 gal/A water to at least 1-acre plots on summerfallow and second-crop land on textures from gravelly to clay loam, April 29 to May 18. Check strips were located adjacent to treated plots. Incorporations were made the same day of application at Buxton and Richardton. At Hatton, harrowing was done immediately and the disking the following morning. The estimated per cent control of wild oats and thinning of wheat, July, 1960, are presented in the table.

	Pct control				Pct thinning			
	Richardton	Hatton	Buxton		Richardton	Hatton	Buxton	
Rate lb/A	Unworked	One-way disk	Disk harrow	Cultivator + harrow	Unworked	One-way disk	Disk harrow	Cultivator + harrow
1.00	0	0	—	—	—	15	0	—	—	—
1.25	0	0	50	77	—	35	10	10	25	—
1.50	0	25	70	75	55	45	25	20	27	10
1.75	0	25	77	78	35	40	20	27	30	30
2.00	0	0	—	—	0	40	50	—	—	50

In every case (with the exception of unworked plots) applications were made to cultivated surfaces. The incorporation moved ridge tops into the furrows, increasing the dosage, eliminating the wheat in rows. Wild oats survived between these rows. The deep incorporation (3 to 4 in) distributed treated soil to seeding depth and diluted the effective dosage. Poor wild oat control combined with severe crop thinning in the unworked plots at Richardton cannot be adequately explained. Where Avadex was applied in 10 gal/A to cultivated surface on loam soil and incorporated immediately with a harrow at Neche, wild oat control and wheat thinning were 85% and 25% respectively, at 1.5 lb/, and 90% and 30%, respectively, at 1.75 lb/A. (Contribution from the Monsanto Chemical Company.)

2,3-Dichloroallyl diisopropylthiolcarbamate (Avadex) for wild oat control in South Dakota, 1960. Selleck, G. W. and Althaus, R. E. Pre-seeding applications of Avadex were applied with farm sprayers at rates from 1 to 3 lb/A to 1-acre plots on soils which varied in texture from loam to clay loam, April 25 to 27, 1960. Incorporation was done the day of application at Doland, and one day later at Aberdeen and Sisseton with implements as shown below. The herbicide was applied in 5 gal water/A at Doland, 9 at Sisseton, and 11 gal/A at Aberdeen. Spring wheat was sown at Aberdeen (2 days later), durum at Doland (after 5 days and harrowed twice), and flax at Sisseton (harrowed, seeded and harrowed after 7 days). The estimated percent control of wild oats and percent thinning of grain, July, 1960, are presented in the following table.

	Pct control				Pct thinning			
	Aberdeen		Sisseton		Spring wheat at Aberdeen		Durum wheat at Doland	
Rate lb/A	One-way disk	Harrow	One-way disk	Two one-way diskings	One-way disk	Harrow	One-way disk	Harrow
1.00	0	0	—	—	0	0	0	0
1.25	45	0	—	—	0	0	5	0
1.50	50	25	50	75	10	4	10	0
1.75	75	75	—	—	30	15	15	0
2.00	10	10	0	50	30	25	25	10
2.50	—	—	0	75	—	—	—	—
3.00	—	—	0	45	—	—	—	—

Avadex at 2.5 lb/A gave good control of green foxtail. Poor wild oat control at Sisseton can be explained by too deep incorporation (in excess of 3 in), and the failure of the incorporation to kill emerged wild oats. At Aberdeen, poor control is attributed to deep one-way disking (4 in) and possible inadequate mixing with the harrow. Another plot at 2 lb/A, (incorporated with a harrow) controlled wild oats 70% and thinned the wheat 30%. At Doland, wild oats were controlled 90% at 1 lb/A (incorporated with a harrow), but were absent in all other plots. (Contribution from the Monsanto Chemical Company.)

2,3-Dichloroallyl diisopropylthiolcarbamate (Avadex) for wild oat control in barley in Minnesota, 1960. Selleck, G. W. and Althaus, R. E. Pre-seeding applications of Avadex at from 1 to 2 lb/A in 10 gal water were made with farm sprayers to 2-acre plots on second-crop land at 3 locations in Minnesota as follows: At Kennedy, on sandy loam soil, the plots were incorporated the day of application, with a spring-tooth harrow vs the spring-tooth plus a spike-tooth, and sown to Trail barley, May 16. At Twin Valley, on clay loam soil, incorporation was done with a harrow vs a disk 2 days after application and seeded at once, and at Mahnomen, on loam soil, with a cultivator vs a tandem disk the same day, and the field was seeded 2 days later. Spraying pressures at Mahnomen, Kennedy and Twin Valley were 60, 34, and 40 psi respectively. The estimated per cent control of wild oats and thinning of barley, July 1960, are presented in the following table.

Rate	Kennedy		Mahnomen		Twin Valley	
lb/A	Control	Thinning	Control	Thinning	Control	Thinning
1.00	—	—	74	0	70	0
1.25	90	30	79	0	0	0
1.50	99	50	78	0	0	0
1.75	95	50	90	0	0	0
2.00	99	75	—	—	—	—

The 2 day delay in incorporation at Twin Valley may account for the poor wild oat control. Barley was adversely affected only at Kennedy where barley was thinned on alternate swathes across each plot. The operator was having sprayer "pressure trouble" which may partially explain this. Where half of the plot area at Kennedy was plowed under and reseeded to Golden flax, wild oat control was maintained as reported above without injury to flax. No significant differences in control or crop damage were noted as a result of variations in soil incorporation. Good control of green foxtail was obtained at 2 lb/A; fair control at 1.5 lb/A. Yield data were taken at Mahnomen. The check plot, 1½ lb/A and 1¾ lb/A rates yielded 12, 46 and 52 bu/A respectively. (Contribution from the Monsanto Chemical Company.)

2,3-Dichloroallyl diisopropylthiolcarbamate (Avadex) for wild oat control in barley in North Dakota, 1960. Selleck, G. W. and Althaus, R. E. Pre-seeding applications of Avadex were applied with a field sprayer at rates from 1 to 4 lb/A in 10 gal water at 40 psi on 2-acre plots on second-crop land on loam soil at Jamestown, N. D., April 28, 1960. Check strips were adjacent to each treated plot. Plots were incorporated to a depth of 4 in with a Graham-Hoeme digger followed by a harrow the day of application and seeded to barley. The estimated and calculated per cent control of wild oats (the latter based on 1 sq yd counts), the per cent thinning of stand and the yield and grade of barley are presented in the table.

			Barley				
Rate	Pct control		Pct	Pct	Yield	Grade	
lb/A	Est.	Calc.	thinning	dockage	bu/A	Plump	Thin
0.00	0	0	0	6	32.3	40	6
1.00	75	88	0	3	47.0	40	6
1.25	80	79	0	3	55.1	42	6
1.50	85	80	0	3	53.4	44	6
1.75	85	91	0	5	51.1	46	6
2.00	75	87	15	6	48.2	32	8
4.00	75	—	50	—	—	—	—

The wild oat population in check plots varied from 18 to 720/sq yd. Avadex at 2 lb/A was applied at Neche, incorporated with a harrow the same day and seeded to Trail barley. Wild oats were controlled 75%. The stand was thinned 35% at the time of germination but as a

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result of tillering, was equivalent to that of the check, July, 1960. (Contribution from the Monsanto Chemical Company.)

Wild oat control in barley with 2,3-dichloroallyl diisopropylthiolcarbamate (Avadex) in North Dakota, 1960. Selleck, G. W. and Althaus, R. E. Pre-seeding applications of Avadex were made with farm sprayers on second-crop land and summerfallow at from 1 to 2.3 lb/A in 9 to 35 gal/A water on plots of at least 1 acre on loam soil as follows: At Melville, Park River and Turtle Lake, plots were incorporated the same day with a double disk vs a spring-tooth harrow; a tandem disk; and a cultivator, respectively. Barley was sown the same day at Melville and Turtle Lake, and 3 weeks after application at Park River. At Grand Forks, the application was made prior to seeding. The estimated per cent wild oat control at 3 locations and thinning of barley at Melville, July 1960, are presented in the table.

Rate lb/A	Pct wild oat control			Pct thinning, Melville	
	Turtle Lake	Park River	Grand Forks	Disk	Spring-tooth harrow
1.00	50	—	—	0	0
1.25	97	99	95	25	0
1.50	93	99	90	25	0
1.75	55	99	90	30	18
2.00	55	99	95	30	30
2.30	97	—	—	—	—

Additional barley thinning occurred only at Park River where 1¾ and 2 lb/A thinned the stand 10%. Wild oats were controlled 100% at Melville at 2 lb/A. They were absent in all other checks. At Turtle Lake, poor control was obtained as a result of deep incorporation in wet depressions. At Park River, incorporation failed to control emerged wild oats, requiring tillage 3 weeks later. The mean yield for treated plots was 32.6 bu/A vs 28.6 bu/A for checks. Another 2 lb/A rate untilled after incorporation yielded 43 bu/A. The untreated check failed to produce a crop but supported 1413 wild oats/sq yd. (Contribution from the Monsanto Chemical Company.)

Fall application of 2,3-dichloroallyl diisopropylthiolcarbamate (Avadex) in spring wheat. 1960. Selleck, G. W. and Skoglund, N. A. Avadex was applied Oct. 21, 1959 at 0.5, 1, and 1.5 lb/A in 34 gal water to ½-acre summerfallow plots on silty clay loam soil at Saskatoon, Sask. Check plots alternated with treated plots. Half of each plot was unworked, the other half single-disked immediately after application. Snow to a depth of 0.5 in was present at the time of application. The whole area was diskered and seeded to Lake wheat May 26/60. The percentage control Aug. 24, 1960, (from quadrat counts) is presented in the table. The wild oat population reached a maximum of 15/½ sq yd in check plots.

Rate lb/A	Pct control	
	Worked	Unworked
0.5	−18.5	1.7
1	47.3	26.7
1.5	44.5	40.0

Thinning or delayed maturity of the wheat was not evident. (Contribution No. 303 from the Dept. of Plant Ecology, Univ. of Saskatchewan, Saskatoon, with financial assistance from the Monsanto Chemical Company.)

2,3-Dichloroallyl diisopropylthiolcarbamate (Avadex) for wild oat control in spring wheat, 1960. Selleck, G. W. and Skoglund, N. A. Pre-seeding applications of Avadex were applied to 1-acre plots May 10 to a natural infestation of wild oats in loose summerfallow on silty clay loam soil at Saskatoon, Sask. A check strip was adjacent to each treated plot. The herbicide was applied at from 1 to 2 lb/A with a farm sprayer in 5.2 gal/A water at 25 lb psi. The 1.05 lb/A rate was applied in 3.6 gal/A. Incorporation consisted of one or two harrowings the same day. The whole area was discered May 25 and seeded to Lake wheat May 26. The percentage control of wild oats was estimated and calculated (the latter from 10, ½ sq yd quadrats in each of treated and check plots) Aug. 24, 1960, as presented below. Estimated percentages are considered to be the more reliable because of the variation in wild oat populations which occurred. Wild oats were absent in check plots adjacent to the 2 lb/A rate but reached 35/½ sq yd in other checks.

Rate lb/A	Harrowed once		Harrowed twice	
	Estimated	Calculated	Estimated	Calculated
1.00	85	93.5	80	55.0
1.05	75	69.2	82	73.5
1.25	80	69.3	80	83.6
1.75	75	84.3	75	82.0
2.00	—	—	—	—

Variations in volume application or soil incorporation did not significantly affect the results. No stand thinning or delayed maturity of the wheat was evident. (Contribution No. 302 from the Dept. of Plant Ecology, Univ. of Saskatchewan, Saskatoon, with financial assistance from the Monsanto Chemical Company.)

Commercial applications of 2,3-dichloroallyl diisopropylthiolcarbamate (Avadex) in wheat, 1960. Selleck, G. W., Garvin, J. W., Wilson, G. S., Laughlin, D. K., and Wallace, G. W. Pre-seeding applications of Avadex were made by farmers in western Canada during 1960 from 1 to 2 lb/A in approximately 10 gal/A water in soil textures from light loam to heavy clay. The data are presented in the table.

Location	Rate lb/A	Variety	Acres treated	Method of incorporation	Pct wild oat control	Pct crop thinning
Alberta						
Lethbridge	2	Chinook	21	tandem disk + harrow	excellent	10
Lethbridge	2	Chinook	10	cultivator + harrow + rod-weeder	—	50
Dalroy	1½	Thatcher	56	disker	90	nil
Munson	1¼	Selkirk	50	disker + rod weeder	good	15
Saskatchewan						
Rosetown	1	Thatcher	165	disker + harrow	90	delayed 3 days
Rosetown	1	Thatcher	5	disker	80	delayed 7 days
Rosetown	¾	Selkirk	5	disker	85	nil
Rosetown	2	Thatcher	5	disker + harrow	excellent	20
Kindersley	1½	Thatcher	10	disker + harrow	90	30
Kelvington	1½	Selkirk	13	disker	90	10
Hendon	1½	Selkirk	8	cultivator	excellent	—
Kelvington	1½	Selkirk	4	harrow	excellent	—
Wapella	1	Selkirk	4	disker	75	25
———	1½	durum	80	cultivator + rod weeder	90	20
Yorkton	2	Selkirk	4	disker	95	45
Tisdale	1½	Thatcher	70	disk	good	30
Unity	1	Thatcher	10	cultivator	poor (poor mixing)	60
Manitoba						
Firdale	1½	Selkirk	5	tandem disk	80	20
Firdale	1½	Selkirk	10	tandem disk + harrow	95	20

Yields were taken at Kindersley where it was initially reported that the 1½ lb/A rate decreased the stand of wheat by 30%. Yield of wheat and dockage were 19 bu/A and 3½% in the treated plot compared with 10.5 bu/A and 8½% in the check. (Contribution from the Monsanto Chemical Company.)

Commercial applications of 2,3-dichloroallyl diisopropylthiolmarbamate (Avadex) for wild oat control in barley in western Canada. Selleck, G. W., Garvin, J. W., Wilson, G. S., Wallace, G. W., and Laughlin, D. K. Pre-seeding applications of Avadex were made by farmers on soil textures which ranged from light loam to heavy

clay at rates from 1 to 2 lb/A in approximately 10 gal water in Manitoba, Saskatchewan and Alberta. A random sampling of the data are presented below.

Location	Variety	Rate lb/A	Acres treated	Method of incorporation	Pct wild oat control	Pct crop thinning
Alberta						
Dalroy	Gateway	1½	150	disker	90	nil
Granum	Campana	1	45	tandem disk	excel.	10
Clover Bar	Gateway	1,1½,2	30	tandem disk + cultivator + harrow + rod weeder	excel. excel.	nil nil
Ready-made	Montcalm	1¼	4	cultivator + harrow	—	40
Purple Springs	Campana	1½	30	tandem disk	90	nil
Saskatchewan						
Kindersley	Montcalm	1½	10	disker + harrow	90	15
Kelvington	Montcalm	1¼	65	cultivator + 2 harrow	90	2 day delay
Kindersley	Montcalm	1¼	15	———	92	30
Rosetown	Hannchen	1½	10	disker + packer	99	nil
Wynyard	Hannchen	1¼	5		90	2 day delay
St. Gregor	Parkland	1½	11	tandem disk + harrow	good	10
Kinistino	Parkland	1½	3	disker	90	nil
Rhein	Montcalm	1¾	10	disker	95 smf. 70 stub	nil
Manitoba						
Balmoral	Herta	1	15	disker + 2 harrow	90	nil
Balmoral	Herta	1	20	disker	95	10
Balmoral	Parkland	1½	25	2 disker	85	nil
Portage La Prairie	———	2	20	disker	85	nil
Rivers	Montcalm	1½	15	cultivator + harrow	90	10
Brandon	Montcalm	1½	20	disk	40	severe
Poplar Point	Montcalm	1½	5	cultivator + harrow	95	nil
Swan River	Parkland	1½	9½	tandem disk, harrow + packer	95	nil

(Contribution from Monsanto Chemical Company.)

Comparison of barban (Carbyne) and 2,6-dichlorobenzonitrile (N-5996) for selective control of wild oats in wheat. Sexsmith, J. J. Thatcher spring wheat was seeded at Lethbridge on May 20, 1960, into a wild-oat-infested dry-land wheat stubble. Barban was applied at ¾ lb/A on June 8 (wild oats 1½- to- 2-leaf, wheat 1½- to 2½-leaf) and on June 23 (wild oats 3- to 4-leaf, wheat 5-leaf), and N-5996 at 3 lb/A on June 23. Quadruplicate 16- by 20-ft plots were treated and one-half of each was treated on June 23 with the butyl ester of 2,4-D at 5 oz/A. Barban and 2,4-D were applied in 14.6 gpa and N-5996 in 23.9 gpa. Yield samples (2 sq yd/subplot) were taken on August 18, the straw being cut at ground level. Air-dry weights were recorded for wild oat straw and wheat straw, and grain yields determined. There was little difference in straw weights or yields between the sub-plots of any treatment, and the data were combined to give the results below.

	W.O. straw		Wheat straw		Wheat grain	
	Gm/ sq yd	Pct of check	Gm/ sq yd	Pct of check	Yield bu/A	Pct of check
Check	54.2	100	179.8	100	20.4	100
Barban, 1½- to 2-leaf	6.5	12	217.8	121	28.4	139
Barban, 3- to 4-leaf	60.5	112	182.5	102	20.8	102
N-5996, 3- to 4-leaf	47.8	88	178.8	99	20.0	98

Barban at ¾ lb/A, applied when wild oats were in the 1½- to 2-leaf stage, gave effective wild oat control while allowing wheat to give a better than 35% yield increase. Neither barban nor N-5996, applied when wild oats were in the 3- to 4-leaf stage, gave effective wild oat control, nor did they affect wheat yields. The wheat crop was not affected by N-5996, but was delayed in maturity a few days by the barban treatments. The early barban treatment gave reasonably effective growth suppression of wild buckwheat. (Canada Dept. of Agriculture, Research Station, Lethbridge, Alberta.)

Comparison of cone and fan nozzles to apply barban for wild oat control at two growth stages in wheat. Sexsmith, J. J. Thatcher spring wheat was seeded at Lethbridge on May 20, 1960, into a wild-oat-infested dry-land wheat stubble. Barban at ½ lb/A was applied to quadruplicate plots on June 8 (wild oats 1½- to 2-leaf, wheat 1½- to 2½-leaf) and on June 14 (wild oats 2- to 2½-leaf, wheat 3-leaf). Nozzles used were: (1) Cone—#X2, 4 to cover 8 ft, 7.2 gpa; (2) Fan—#650067, 4 to cover 8 ft, 7.2 gpa; (3) Fan—#650067, 8 to cover 8 ft, 14.6 gpa. Yield samples (2 sq yd/plot) were taken on August 18, the straw being cut at ground level. Air-dry weights were recorded for wild oat straw and wheat straw, and grain yields determined.

Because of non-uniformity of the wild oat infestation along edge of plot area the data were not too conclusive, and therefore the interpretation of results is based on observations as much as on the data obtained. Good control of wild oats resulted from early treatments, made when wild oats were in the 1½- to 2-leaf stage. At this stage the fan nozzles gave better results than did the cone, with some slight advantage evident for the coverage obtained with 8 nozzles for an 8-ft width at the greater spray volume. Treatments made at the 2- to 2½-leaf stage of wild oats were slightly less effective than were earlier treatments, and there was little if any difference between the effects of barban as a result of nozzle type used. All treatments caused a 3- to 5-day delay of the maturity of the wheat. Barban at ½ lb/A gave an increased wheat yield of approximately 30% over the untreated check yield of 25 bu/A. (Canada Dept. of Agriculture, Research Station, Lethbridge, Alberta.)

OTHER FIELD CROPS

FLAX

Herbicides for weed control in flax. Chubb, W. O. Redwood flax, infested predominantly with green foxtail (about 50 plants/sq ft), was treated with butyl ester of 2,4-D at 6 oz/A, butyl ester of MCPA at 8 oz/A, and butyl ester of MCPA at 8 oz/A mixed with TCA at 3, 4.25, and 6 lb/A or dalapon at 12, 17 and 24 oz/A, in total spray volumes of 5 and 15 gpa (Imp.), with water as diluent. Treatments were applied when the flax was at the 4 to 5-leaf stage and the green foxtail was in the 2 to 3-leaf stage. Weeded and unweeded checks were included in the test. A factorial design with four replicates (plot size 1/1000 A) was used. The test was grown on a fertile clay loam soil. Moisture supply was excellent in the spring but the summer was very dry. Control of green foxtail was very satisfactory at all rates of TCA and dalapon, although not complete except at the highest rates. The effect of spray volume was not significant. Yield differences between TCA and dalapon and between rates of TCA and dalapon were not significant. As compared with the weeded checks flax on plots infested with green foxtail suffered a 30% loss in yield. Treatment with TCA or dalapon reduced this yield loss by about 60% but the yield from the weeded plots was significantly greater than from any of the treated plots. Yields were as follows (in 100 lb/A): Weeded check—16.5; MCPA 8 oz/A + TCA 3 lb/A, 15.0, 4½, 14.2, 6, 14.1; MCPA 8 oz/A + dalapon 12 oz/A, 14.6, 17, 14.8, 24, 14.6; MCPA 8 oz/A, 11.3; 2,4-D 6 oz/A, 10.7; check, 11.5. (Contribution of Canada Agr., Research Branch, Portage la Prairie, Manitoba.)

2,3-Dichloroallyl diisopropylthiolcarbamate (Avadex) for pre-planting control of wild oats in flax (natural infestation). Gorby, B. J. On May 21, 1960, Avadex was applied at 1, 1.5, 2, and 2.5 lb/A in 5 gallons of water at 30 psi to a naturally wild-oat-infested summerfallow on the Durban Research Project Farm. Uniform seeding of Marine flax followed one stroke of a wide level discer

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to effect immediate incorporation. Warm and calm weather facilitated the operation and subsequent germination.

Avadex rate lb/A	Productive W. O. tillers sq yd	Pct control W. O. tillers	Threshed wt seed W. O. lb/A	Flax bu/A
0	233	0	362	5.7
1	112	52	256	12.1
1.5	77	67	277	11.8
2	56	76	181	13.7
2.5	70	70	256	12.8

L.S.D. @ 5% level for treatments, 6.0 bu/A flax

All rates of Avadex reduced the population of wild oats from 52 to 76 per cent on a tiller count basis. Maximum reduction occurred at the 2 lb/A application. All rates of Avadex increased the yield of flax seed significantly. No flax injury appeared at the application rates used in this test. (Research Branch, Experimental Farm, Brandon.)

Effect of pre-planting treatments on wild oats in flax. Molberg, E. S. and J. D. Banting. 2,3-dichloroallyl diisopropylthiolcarbamate (Avadex) was applied as a pre-planting treatment for the control of wild oats in Marine flax on summerfallow and stubble land. Rates of 1, 1.5, 2, and 2.5 lb/A were applied in spray volumes of 5 and 10 gpa and incorporated immediately by a single discer operation. The plots were sown with a double disc drill the day following herbicide application and were packed immediately after seeding. On summerfallow the check plots contained 121 wild oat plants/sq yd and yielded 5.4 bu/A. The treatments reduced the number of wild oat plants from 75 to 95% as the application rate was increased from 1 to 2½ lb/A and increased yields by 3 to 8 bu/A. The effects of spray volume were small but quite consistently in favour of the 10 gpa treatments. The average wild oat control and yield increases for the different rates were as follows: 1 lb—76.4%, 4.2 bu; 1.5 lb—85.1%, 4.2 bu; 2 lb—88.0%, 5.2 bu; 2½ lb—90.5%, 7.6 bu. On stubble the check plots contained 73 wild oat plants/sq yd and yielded 5.8 bu/A. The treatments reduced the number of wild oat plants by 69 to 96% and increased flax yields by 1 to 3.5 bu/A. The effect of spray volume was similar to that on summerfallow. The average wild oat control and yield increases per acre were as follows: 1 lb—70%, 1.5 bu; 1.5 lb—83.3%, 2.0 bu; 2 lb—94.6%, 1.9 bu; 2.5 lb—90.8%, 2.9 bu. (Contributed by the Research Branch, Experimental Farm, Regina, Saskatchewan.)

2,3-Dichloroallyl diisopropylthiolcarbamate (Avadex) for wild oat control in Norland flax, 1960. Selleck, G. W. Pre-seeding applications of Avadex were made to 1-acre plots on summer fallow loam soil May 5 at Esterhazy, and to stubble on heavy clay soil at Riceton, Sask., May 24. The herbicide was applied with farm sprayers at rates from 1 to 2 lb/A in 6.25 gal water at 30 psi at Esterhazy and in 9.4 gal water from 12 to 20 psi at Riceton. At Esterhazy, plots were incorporated with a disker after 12 hours and after 3 days, and with a duckfoot cultivator after 12 hours. The latter plots were harrowed the following day. At Riceton, plots were sprayed in the evening, diskered the next morning and sown 4 days later. At Esterhazy, the area was diskered, harrowed and seeded after 27 days. The estimated percentage control as verified by quadrat counts August, 1960, are presented below.

	Esterhazy			Riceton	
Rate lb/A	Diskered after 3 days	Diskered after 12 hours	Cultivated after 12 hours	Diskered twice	Diskered once
1.00	57	63	63	92	85
1.25	75	85	85	94	92
1.50	75	82	92	95	96
1.75	75	92	92	95	95
2.00	90	95	98	99	99

At Esterhazy, the maximum wild oat population in the check strips reached 198 culms, compared with 513/sq yd at Riceton. At Esterhazy wild oat control was inadequate where the cultivator penetrated below 3 in. in wet areas. Flax was not adversely affected in any of the tests. Avadex at 1.5 lb/A in 4.8 gal water was applied at Riceton in wind velocities of 10 mph and later in the day at 30 to 50 mph. Wild oat control was 95 and 25% respectively. In another test, the 1.5 lb/A rate incorporated the same day controlled wild oats 95% compared with 50% with incorporation delayed 4 days. (Contribution from the Monsanto Chemical Company.)

Commercial applications of 2,3-dichloroallyl diisopropylthiolcarbamate (Avadex) in flax in Manitoba, 1960. Selleck, G. W., Garvin, J. W., Wallace, G. W., Laughlin, D. K., and Wilson, G. S. Pre-seeding applications of Avadex were made by farmers at rates from 1¼ to 2 lb/A in approximately 10 gal/A water on soil textures which varied between sandy loam and clay loam and seeded to flax. Data from a random sampling of the locations are presented in the following table.

Location	Rate lb/A	Variety	Acres treated	Method of incorporation	Soil texture	Pct control Wild oats	Pct control Green foxtail
Stonewall	1½	Marine	35	Tandem disk + harrow	Sandy loam	95	75
Beaujour	1¼	——	35	Tandem disk	Sandy loam	50	—
Landmark	1½	Raja	5	Disker + harrow	Loam	95	—
Lillyfield	1½	Marine	130	One-way	Clay loam	89	—
Stonewall	2	Marine	50	One-way disk	Clay loam	95	80
Fortier	1¼	Marine	20	Disk + cult. + harrow	Sandy loam	85	—
Fortier	1½	Marine	20	Disk	Clay loam	90	—
Portage La Prairie	2	Marine	10	One-way disk	Loam	95	—
Rivers	1½	Redwood	130	disk + harrow	Clay loam	90	—
Kennville	1¾	Marine	23	One-way disk	Sandy loam	85	—
Justice	2	Marine	20	One-way disk + harrow	Light loam	95	—
Swan River	1¼	Marine	75	One-way disk + harrow	Sandy loam	90	—
Dauphin	1½	Marine	49	Double-disk	Clay loam	poor	—

Similar data from 45 locations involving 2702 acres in Saskatchewan and Alberta provided similar results. Of these, 90% or better control was reported from 39 locations; between 75 and 80% at 3 locations and 50% at 3 locations. (Contribution from Monsanto Chemical Company.)

Wild oat control in flax with 2,3-dichloroallyl diisopropylthiolcarbamate (Avadex), 1960. Selleck, G. W. and Althaus, R. E. Pre-seeding applications of Avadex were applied with farm sprayers at rates from 1 to 2 lb/A from 18 to 30 psi in 3 to 8 gal/A water to plots of at least 1 acre on second-crop and summerfallow land on soil textures from loam to clay between May 2 and June 3. Check strips were adjacent to treated plots. Incorporation was to a depth of 3 to 4 in. on the same day at Durbin, N. D. and the following morning at other locations. The time of seeding of flax varied from the day of application to a delay of 3 weeks. The estimated percentage control of wild oats July 1960, is presented below.

	Stanley, N. D.		Hallock, Minn.	Leeds, N. D.
Rate lb/A	hoe drill	One-way disk	Spring-tooth harrow	Double disk + hoe drill
1.00	85	95	—	99
1.25	80	90	85	99
1.59	63	95	90	95
1.75	50	99	85	97
2.00	65	99	—	97

The wild oat population in check strips varied between 20 and 468/sq yd. At Durbin, the whole area

was tilled after 3 weeks, and then seeded. In July, 1960 wild oats were entirely absent in plots and checks. At the time of tillage, however, the farmer reported 90% control of wild oats at 1.75 lb/A. At Mahnomen, Minn. where only 2 lb/A was applied, and incorporated to a 4 in depth, 90% control of wild oats was obtained. There were no adverse effects to flax at any of the locations. (Contribution from the Monsanto Chemical Company.)

PROCESSING PEAS

Pre-emergence weed control in processing peas, 1960. Nelson, D. C., Weaver, M. L., and Nylund, R. E. Processing peas seeded at two locations in Minnesota (May 5 at Stewartville in silt loam soil and May 18 at Gibbon in silty clay loam soil) were sprayed with the following herbicides: 2 lb/A diuron, 4 lb/A CDAA, 11 and 14 lb/A CDAA-T (29% CDAA plus 71% trichlorobenzyl chloride), 2 and 4 lb/A amiben, 4 lb/A trietazine, 6 and 12 lb/A dimethyl 2,3,5,6-tetrachloroterephthalate (Dacthal), 5 and 10 lb/A 6-nitro-2,4-dichlorophenol (O.M. 1306), and 2 and 4 lb/A 2,6-dichlorobenzonitrile (Casoron). Herbicides were applied at 30 psi pressure in 40 gpa of water to duplicated one-half square rod plots. Every third plot was an unsprayed check. At Gibbon, herbicides were applied the day after seeding to a wet soil. In the two days following spraying rainfall totaled 1.48". Principal weed species were *Amaranthus retroflexus*, *Polygonum persicaria*, *Setaria* spp., and *Echinochloa crusgalli*. At Stewartville herbicides were applied 5 days after seeding to a moist soil. The first rains occurred 5 days (.07") and 6 days (.22") after spraying. Principal weeds were *Brassica* spp., *P. persicaria*, *Setaria* spp., and *E. crusgalli*. Only 11 and 14 lb/A CDAA-T injured peas. Five weeks after spraying the following herbicides gave satisfactory control (85-100%) of both broad-leaved and grassy weeds: at Gibbon, 11 and 14 lb/A CDAA-T and 2 and 4 lb/A amiben; at Stewartville, 2 lb/A diuron and 4 lb/A trietazine. Two and 4 lb/A amiben gave satisfactory control of grassy weeds at both locations. (Paper No. 4490 of the Scientific Journal Series of the Minnesota Agr. Exp. Sta.)

Wild oat control in processing peas. Sexsmith, J. J. A split-plot test was set out on a silty clay loam irrigated soil at Lethbridge in 1960 to test for wild oat control in Dark Skin Perfection peas. Pre-planting applications, followed by disking in two directions, made on the day of seeding (May 11), included IPC at 4, 6, and 8 lb/A; EPTC at 1, 2, and 3 lb/A; 2,3-dichloroallyl diisopropylthiolcarbamate (Avadex) at 1½, 2, and 3 lb/A; and trietazine at 1½, 2, and 3 lb/A. Post-emergence applications of barban at ½, ¾, and 1 lb/A were made on June 3 when wild oats were in the 1½- to 2½-leaf stage and the peas in the 2- to 3-joint stage up to 3 inches tall. Stand counts of peas were taken on June 2, wild oat control estimates on June 14, and the complete plots of three replicates were harvested for shelled pea yields on July 25 to 28. The wild oat infestation was determined at 83 plants/sq yd. As noted on June 14, all rates of IPC caused some stunting, and reduced pea stands by 20 to 30%; the higher rates of EPTC caused slight stand thinning with some stunting and leaf rolling; Avadex caused leaf rolling that was severe at 3 lb/A; trietazine at highest rate caused slight yellowing; and barban at the higher rates caused slight stunting. Results for wild oat control and shelled pea yield are given below as fractions, with the per cent control as the numerator and yield (per cent increase over check) the denominator (rates in lb/A): IPC, 4, 97/80, 6, 99/83, 8, 99/56; EPTC, 1, 88/121, 2, 98/98, 3, 99/107; Avadex, 1½, 92/95, 2, 94/73, 3, 95/82; trietazine, 1½, 20/171, 2, 30/118, 3, 50/147; barban, ½, —/61, ¾, —/62, 1, —/59. No wild oat control data were available for barban, but it was noted that a fair number of the wild oats were killed and general growth suppression was good from the ½-lb rate and excellent from the ¾- and 1-lb rates. It should be noted that the wild oat control resulting from IPC in 1960 was much better than had been obtained previously, and the 97% control from 4 lb compares with 78% as averaged for the five previous seasons. (Canada Dept of Agriculture, Research Station, Lethbridge, Alberta.)

Comparative effectiveness of acetic and butyric herbicides for weed control in processing peas. Sexsmith, J. J. A quadruplicate test was conducted on Dark Skin Perfection peas, grown on a silty clay loam irrigated soil at Lethbridge, Alberta, in 1958 and 1959 to compare the sodium and amine salts of MCPA at 4, 6, and 8 oz/A with the sodium salts and butyl esters of 4-(MCPB) and 4-(2,4-DB) at 16, 20, and 24 oz/A, applied at spray volumes of 19.2 and 23.9 gpa in the respective years. In 1958 and 1959 the dates of the various procedures were: seeding, May 6 and May 30; spray treatment, June 5 and July 7; harvest for shelled green pea yields, July 24 and August 5 to 7. Treatments were applied in each year when the peas were in the 2- to 4-joint stages, and weed control and crop injury ratings were made approximately one month after treatment. Weed growth on the plots consisted of a medium heavy infestation of mixed common lambsquarters and rough pigweed, with a predominance of the latter in 1959. Small patches of perennial sowthistle were scattered throughout the plot area. Although giving better weed control than other materials, the esters of the butyric compounds resulted in more pronounced visible crop injury and maturity delay than did the acetic and other butyric compounds and also caused a reduction in shelled pea yield, the yield reduction being approximately 15% from the ester of 4-(MCPB) and 50% from the ester of 4-(2,4-DB). Better control of redroot pigweed was obtained in 1959 than in 1958, but the relative effectiveness of the different materials and rates was consistent in the two seasons. The sodium salts of both 4-(MCPB) and 4-(2,4-DB) at 20 oz/A were equal to the 6 oz/A rates of the sodium and amine salts of MCPA for the control of common lambsquarters, gave slightly better control of redroot pigweed, and resulted in a 15% increase over untreated checks in shelled green pea yields as compared with a 5% to 10% increase for the MCPA compounds. The 20 oz/A rates of the butyrics gave better top-growth control of perennial sowthistle than did the 6 oz/A rates of MCPA. Although not proved in this test, the same situation for control of Canada thistle has been observed in other test plots and field applications in the area. (Canada Dept. of Agriculture, Research Station, Lethbridge, Alberta.)

SUGAR BEETS

Herbicides on sugar beets. Bondarenko, D. D. and Ascheman, R. E. Sugar beets were planted in 32-inch rows in Hoytville silty clay loam at Hoytville on April 13, 1960, and in Celina silt loam at Findlay on April 15. Triplicate plots randomized in blocks were band-treated (20-22-inch bands) with each rate of each herbicide listed in the following table. All herbicides were applied in 40 gpa water (overall rate). All plots at both locations had a natural infestation of smartweed, lambsquarters and common ragweed. The plots were rated on May 17 at Findlay and on May 25 at Hoytville before the first cultivation. The ratings are the averages of the three replications.

The plots treated post-emergence by TD-47 and TD-62 at 1½ lb/A at Findlay showed slight beet damage at harvest. No other plot at either location showed herbicide damage to beets at harvest.

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Herbicide lb/A	Rating* of effect on: Sugar beets Fin.	Sugar beets Hoy.	Smartweed Fin.	Smartweed Hoy.	Lambsquarters Fin.	Lambsquarters Hoy.	Ragweed Fin.	Ragweed Hol.
Herbicides applied pre-emergence								
Endothal								
4	0	0	9.8	4.3	9.2	3.3	9.5	4.0
6	0.2	0	9.8	5.8	9.7	4.5	9.8	5.0
Endothal + TCA								
2 + 4	0	0	9.7	8.0	9.3	6.8	9.7	7.5
2 + 6	0	0	9.8	8.8	9.7	8.2	9.7	8.8
3 + 4	0	0	10.0	8.0	9.7	7.0	10.0	7.7
4 + 4	0.5	0	9.8	8.3	9.7	8.2	9.8	8.3
Endothal + dalapon								
2 + 4	0	0	9.5	7.2	9.5	6.3	9.7	7.2
3 + 4	0.2	0	9.3	8.2	9.7	7.8	9.8	8.7
4 + 4	0.8	0	10.0	8.3	9.8	7.8	10.0	8.2
EPTC								
4	0	0	5.5	3.3	4.8	3.0	4.8	3.0
6	0	0	5.3	3.7	5.3	3.7	5.0	3.7
TD-47 (mixed amine salts of endothal, amines derived from coconut oil)								
4	0	—**	9.2	—	8.7	—	9.3	—
6	0	—	9.2	—	8.8	—	9.2	—
TD-62 (mixed amine salts of endothal, amines derived from tallow)								
4	0	—	9.5	—	8.8	—	9.5	—
6	0	—	9.5	—	8.3	—	9.2	—
TCA								
4	0.3	0	5.3	5.7	2.3	3.7	2.3	3.3
6	0	0	6.5	8.0	3.0	6.7	3.0	6.7
Dalapon								
4	0	0	2.0	3.7	1.7	2.3	1.7	1.7
Herbicides applied at the 2-4-leaf stage								
Endothal								
¾	0.3	0	9.3	7.5	8.5	5.7	9.0	5.8
1½	0	0	9.8	9.8	9.3	4.3	9.7	5.5
Dalapon								
3	0.3	0	2.3	2.2	2.0	1.3	2.0	1.7
4	0.0	0	3.3	2.7	2.3	1.0	1.7	1.0
Endothal + dalapon								
½ + ½	0.0	0	8.8	3.3	8.2	3.3	8.2	3.3
TD-47								
¾	0.5	0	9.5	8.8	8.5	6.8	9.0	8.2
1½	3.0	0	9.8	10.0	9.7	7.8	9.8	8.0
TD-62								
¾	1.8	0	9.5	9.5	9.0	6.8	9.2	7.8
1½	4.8	0	10.0	10.0	10.0	9.3	9.8	9.3

* Rated on basis of 0 = no apparent effect; 10 = all plants killed.

** TD-47 and TD-62 not applied pre-emergence at Hotyville.

(The Ohio Agr. Exp. Sta.)

Commercial applications of 2,3-dichloroallyl diisopropylthiolcarbamate (Avadex) in sugar beets and rapeseed in western Canada, 1960. Selleck, G. W., Garvin, J. W., Wallace, G. W., Laughlin, D. K. and Wilson, G. S. Pre-seeding applications of Avadex were made by farmers in western Canada at rates from 1 to 2 lb/A in approximately 10 gal water and seeded to sugar beets and Golden rapeseed. A random sampling of the data are presented in the following table.

Location	Rate lb/A	Acres treated	Method of incorporation	Pct wild oat control	Crop injury
Sugar beets					
Alberta					
Diamond City	2	32	tandem disk + harrow	excellent	nil
Readymade	1½, 2	22	tandem disk	excellent	nil
Readymade	2	25	tandem disk	80	present on ½ acre
Readymade	2	16	springtooth + 2 harrow + packer	excellent excellent	nil nil
Coaldale	1½	10	tandem disk	excellent	nil
Manitoba					
Landmark	¾	10	disker	80	nil
Landmark	1½	10	disker	95	nil
Landmark	¾	10	one-way or harrow	75	nil
Landmark	1½	10	one-way or harrow	95	nil
Portage La Prairie	1½	70	rotary cultivator + 5 harrow	80	nil
Rapeseed					
Saskatchewan					
Valparaiso	1½	20	disker	95	nil
Rosetown	1	30	disker	92	nil
Tisdale	1½	130	disker	good	nil

(Contribution from the Monsanto Chemical Company.)

Band application of herbicides for wild oat control in sugar beets. Sexsmith, J. J. Five off-station tests were conducted in 1960 to determine the effectiveness of two rates of three pre-planting and two post-emergence herbicides for the control of wild oats in sugar beets. Triplicate 4-row by 50-ft plots were treated on 10-inch bands with a tractor-mounted spray unit, the pre-planting applications being worked in wth mounted Howry-Berg tiller units. The wild oat infestation was determined to range from 76 to 250 plants/sq yd at the various locations, and unthinned beet stands ranged from 100 to 176 plants/24 ft of row. Pre-planting treatments were: 2,3-dichloroallyl diisopropylthiolcarbamate (Avadex) at 1½ and 2 lb/A, EPTC at 2 and 3 lb/A, and endothal at 4 and 6 lb/A. Post-emergence treatments were: dalapon at 3 and 5 lb/A and barban at ½ and 1 lb/A. Stand counts of beets and wild oats were taken for the pre-planting treatments and estimates of wild oat suppression made for the post-emergence treatments. Yield results are not available. A summary of the counts taken on beets and wild oats is given below, results for wild oats being for only four of the five locations because of the incomplete infestation of the plot area at one location.

	Avadex 1½ lb	Avadex 2 lb	EPTC 2 lb	EPTC 3 lb	Endothal 4 lb	Endothal 6 lb
Unthinned beet stand —as pct of checks	105	101	97	91	93	86
Wild oat control, pct	77	83	82	98	38	42

Only the higher rate of EPTC and both rates of endothal reduced the beet stand. A reduction of 25% resulted at only two locations and there only from endothal at 6 lb/A. As judged about two weeks after stand counts were taken and post-emergence applications made, visible injury to beets was noted only for the higher rate of both EPTC and dalapon. Wild oat control was somewhat variable, particularly for endothal, for which herbicide ineffective control resulted in all but one location for all but the higher rate. Avadex did not give good control of wild oats at one location where the soil was very wet and a heavy crop of wild oats had been turned under immediately before treatment. Growth suppression of wild oats was assessed as poor from dalapon, and for barban as fair and good from the ½- and the 1-lb/A rates, respectively. (Canada Dept. of Agriculture, Research Station, Lethbridge, Alberta.)

Wild oat control in sugar beets. Sexsmith, J. J. A split-plot test was conducted on a silty clay loam irrigated soil at Lethbridge in 1960 to compare the overall application of several herbicides for the control of

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wild oats in Kuhn sugar beets. The pre-planting treatments, applied on May 9 and immediately disked in two directions, were IPC at 4, 6, and 8 lb/A; sodium salt of TCA at 10, 15, and 20 lb/A; EPTC at 2, 3, and 4 lb/A; and 2,3-dichloroallyl diisopropylthiolcarbamate (Avadex) at 1½, 2, and 3 lb/A. Beets were seeded on May 10. Dalapon at 3, 4, and 5 lb/A, and barban at ½, ¾, and 1 lb/A were applied post-emergence on June 3 when wild oats were in the 1½- to 2½-leaf stage and beets had two true leaves to 1¼ inches long. Wild oat and beet counts were taken on June 2, control estimates and beet condition noted on June 13, and wild oat suppression estimates for post-emergence treatments made on June 23. The wild oat infestation was determined to be 60 plants/sq yd. Sugar beet yield data were not available. Excellent wild oat control resulted from all pre-planting treatments, with the exception of TCA, the least control, 93%, resulting from Avadex at 1½ lb/A, the other rates of Avadex and all rates of IPC and EPTC giving from 96 to 99% control. The three rates of TCA gave only 52, 68, and 78% control, which is below the considered acceptable minimum of 85%. Post-emergence treatments with barban gave good control of wild oats from ½-lb/A and excellent suppression from ¾ and 1 lb/A whereas even the 5 lb/A of dalapon gave ineffective control of wild oats. Unthinned beet stands were reduced 15% to 25% by the two higher rates of IPC and TCA. Other treatments had no effect on stands. Beets were slightly delayed and leaves somewhat curled by EPTC. Barban did not seem to affect beets, but dalapon, particularly at the highest rate, caused some leaf-edge roll, yellowing, and delay. It should be noted that wild oat control from IPC was much better in 1960 than in former years, the 97% control from 4 lb/A comparing with a five-year average from past seasons of 78% control. (Canada Dept. of Agriculture, Research Station, Lethbridge, Alberta.)

OTHER CROPS

Pre-emergence and post-emergence weed control in sweetclover. Burnside, O. C. and Gorz, H. J. Madrid sweetclover was planted in Sharpsburg silty clay loam at Lincoln, Nebraska, on April 20, 1960. Pre-emergence and post-emergence herbicide applications were made on April 21 and May 11, respectively, to triplicated square-rod plots in 20 gallons of water per acre. Major weeds were *Setaria* spp., *Amaranthus retroflexus*, *Polygonum* spp., and *Helianthus annuus*. The treatments applied and dry-weight yields of weeds and sweetclover on July 15 are presented as follows:

Treatment	Rate lb/A	Yield lb/A Grassy weeds	Broadleaf weeds	Sweetclover
None (weedy check)	—	110	2830	1220
Pre-emergence applications:				
Amiben	2	320	2660	1440
Amiben	4	70	2880	1510
Amiben granules	4	50	2300	1510
Amiben	8	130	2150	1830
Trietazine	1	980	3220	490
Trietazine	2	810	2350	670
Trietazine	4	570	2220	210
EPTC	3	330	2500	650
Post-emergence applications:				
Amiben	4	500	1880	1960
Trietazine	2	840	1450	520
Dalapon	2	50	2730	1200
Dalapon + 4-(2,4-DB)	1 + ½	430	2500	650
Dalapon + 4-(2,4-DB)	2 + ½	140	2740	810

A 4-lb/A post-emergence application of amiben resulted in the best weed control and the highest sweetclover yields. Greenhouse studies indicate that pre-emergence applications of 2 ppmw of amiben destroy *Setaria* spp. but do not reduce the dry-weight yield of 60-day-old Madrid or Spanish sweetclover. A 4 lb/A pre-emergence field application of amiben, on May 14, to adjacent plots of soybeans resulted in season-long weed control without cultivation, whereas the same application in the sweetclover experiment did a poor job of weed control. The differential weed control in the two experiments appears to be the result of differential rainfall after application. No rain fell the first week and only 0.49 inch the second week after pre-emergence applications to sweetclover; however, 1.42 inches of rain fell the first week and 1.18 inches the second week after pre-emergence applications to soybeans. From the data obtained, it is evident that amiben must be leached into the soil to be absorbed by germinating weed seedlings. Once a weed is established it becomes more resistant to most herbicides and it also has many roots in the deeper, herbicide-free soil. Since ample soil moisture was available when the sweetclover was planted and little rain fell shortly thereafter, it appears that weeds became well established before the herbicide was leached into the root zone. (Contribution of the Department of Agronomy, University of Nebraska, Lincoln, Nebraska, Paper No. 1083A, Journal Series, and the Crops Research Division, Agr. Res. Service, U.S.D.A.)

CDAA, EPTC, amiben, and propazine for weed control in crop species of potential industrial uses. Robinson, R. G. Twelve species at Rosemount, Minn. were rated for tolerance to pre-emergence applications of CDAA at 4 lb/A, EPTC at 3 lb/A, amiben at 3 lb/A, or propazine at 3 lb/A. EPTC was raked into the soil after spraying. Planting dates of May 4 and June 1 were compared.

Cold wet weather followed the May 4 applications, and CDAA and EPTC did not control weeds. Propazine and amiben killed *Polygonum convolvulus* and *P. persicaria* and partially controlled *Setaria sp.* Propazine gave better control than amiben. Following the June 1 applications, all herbicides gave satisfactory weed control except that EPTC was somewhat less effective than the others and CDAA controlled grass weeds only.

Crop tolerance was rated on a scale of 0, no injury, to 5, killed. Ratings of 0-2 indicate potential selective use.

Crop	Crop tolerance to CDAA	EPTC	amiben	propazine
Helianthus annuus	0	0	0	3
Sorghum almum	1	5	4	1
Limnanthes douglassii	2	3	2	5
Rudbeckia bicolor	4	4	2	5
Brassica campestris	2	3	3	5
Brassica napus	1	2	3	5
Crambe abyssinica	2	2	3	5
Eruca sativa	1	2	2	5
Raphanus sativus	1	2	2	5
Foeniculum vulgare	1	0	—	—
Daucus carota	1	—	—	—
Euphorbia heterophylla	0	—	—	—

(Contribution from the Department of Agronomy and Plant Genetics, University of Minnesota, St. Paul. Paper No. 4499, Sci. Jour. Series, Minnesota Agric. Expt. Sta.)

2,3-Dichloroallyl diisopropylthiolcarbamate (Avadex) for wild oat control in rapeseed, 1960. Selleck, G. W. Avadex was applied at rates from 1 to 2 lb/A in 10 gal water and 35 psi with a farm sprayer on 1-acre plots on summerfallow of loam texture at Naicam, Sask., May 11, 1960. Untreated checks were located adjacent to treated plots. Half of them were diskered immediately after application. The remainder were harrowed the following morning and the whole area seeded to Golden rapeseed. The estimated percentage control of wild oats are presented below. In every instance higher percentage

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control was obtained by quadrat counts than by estimations.

Rate lb/A	Diskered and harrowed	Harrowed twice
1.00	75	55
1.25	85	75
1.50	95	95
1.75	99	95
2.00	99	95

At Spalding the effectiveness of the 1.5 lb/A rate was compared at 4.2 gal and 8.4 gal/A water and with incorporation delayed 8 days. The plots were seeded to Polish rapeseed 25 days after application. Control was as follows: 4.2 gal volume, 85%; 8.4 gal, 99%; immediate incorporation, 99%; incorporation after 8 days, 75%. None of the applications affected the rapeseed. In summerfallow at Naicam where Avadex was applied in 1959, the wild oats numbered 155/sq ft in the check, compared with 10/sq ft at the 2.5 lb/A rate. (Contribution from the Monsanto Chemical Company.)

Air vs ground applications of 2,3-dichloroallyl diisopropylthiolcarbamate (Avadex) for wild oat control, 1960. Selleck, G. W. and Althaus, R. E. Pre-seeding applications of Avadex were made at 2 lb/A with ground sprayer in 10 gal water and by air in 3 gal water to loam soil at Neche, May 14 and at Grand Forks, from 1.5 to 2 lb/A were applied with a farm sprayer in 35 gal water to loam soil, May 16. All plots were at least 1-acre in size with untreated check strips located adjacent to them. All plots were incorporated with a harrow the same day of application and seeded to potatoes and beets at Grand Forks, and flax, field peas, barley and durum wheat at Neche. The estimated percentage control of wild oats is presented below.

Rate	Grand Forks		Neche					
		Sugar	Flax		Field peas		Barley	
lb/A	Potatoes	beets	Air	Ground	Air	Ground	Air	Ground
1.50	92	85	—	—	—	—	—	—
1.75	95	90	—	—	—	—	—	—
2.00	95	95	90	95	95	95	0	80

None of the crops was adversely affected by any of the treatments. The 2 lb/A rate was applied at Neche by air in 3 gal water vs 3 gal oil, incorporated with a harrow the same day of application and seeded to durum wheat. Neither treatment had any adverse affect on wheat or wild oats. (Contribution from the Monsanto Chemical Company.)

Commercial applications of 2,3-dichloroallyl diisopropylthiolcarbamate (Avadex) in special crops in western Canada, 1960. Selleck, G. W., Garvin, J. W., Laughlin, D. K. and Wallace, G. W. Commercial applications of Avadex were applied at rates from 1 to 2 lb/A in approximately 10 gal of water to peas, sunflower and potatoes in Alberta and Manitoba. The data are presented below.

Location	Variety	Rate lb/A	Acres treated	Method of incorporation	Wild oat control	Crop injury
Peas						
Magrath, Alberta	Early Perfection	1½	4	tandem disk	excel.	nil
Coaldale, Alberta	Dark skinned Perfection	1½	4	tandem disk	excel.	nil
Poplar Point Manitoba	Arthur	1½	2½	cultivator + harrow	95%	nil
Sunflowers						
Warner, Alberta	CM5xCM27	1,2	130	rotary hoe	satis.	nil
Potatoes						
Lethbridge, Alberta	Gem	2	30	cultivator	excel.	nil

(Contribution from the Monsanto Chemical Company.)

Weed control in a variety of crops. Sexsmith, J. J. Duplicate 8- by 28-ft plot areas of a silty clay loam irrigated soil at Lethbridge were sprayed on May 27, 1960, with 2,3-dichloroallyl diisopropylthiolcarbamate (Avadex) at 1½ and 2 lb/A and 2-chloroallyl dipropyldithiocarbamate (CP 7667) at 2 and 4 lb/A, applied at solution rates of 34.3 gpa and immediately disked in two directions. The following day 13 crops were seeded across each plot. Weed control and crop injury ratings were taken on July 14. Avadex gave 96 and 97% control of wild oats and fair and good control of green foxtail at 1½ and 2 lb/A, but neither rate gave any control of broadleaf annual weeds. CP 7667 gave 70 and 90% control of wild oats at 2 and 4 lb/A and neither rate gave better than poor control of either green foxtail or mixed broadleaf annuals. There was little difference between the higher rates of the two herbicides in potatoes, cucumbers, carrots, red and sugar beets, mustard, flax, sunflower, or corn, for which the visible injury was rated as none to slight. Both herbicides at the higher rate caused slight to moderate in jury to processing peas and for the other three crops CP 7667 was less injurious than was Avadex, which caused moderate injury to beans and Harlan barley and moderate to severe injury to Thatcher wheat. (Canada Dept. of. Agriculture, Research Station, Lethbridge, Alberta.)

Use of barban for wild oat control in a variety of crops. Sexsmith, J. J. Barban at ½ and 1 lb/A was sprayed on duplicate 8- by 28-ft plots at 7.2 gpa on June 14, 1960. The plots had been seeded to 13 crops 17 days previously and contained a reasonably heavy infestation of wild oats and mixed broadleaf annuals (redroot pigweed and common lambsquarters) as well as some green foxtail. When treated, the wild oats were in the 2- to 2½-leaf stage. Weed suppression and crop injury ratings were made one month later. Some killing and fair growth suppression of wild oats resulted from ½-lb and fair to good suppression from 1-lb/A of barban. No effect of treatment was noted on green foxtail or broadleaf weeds. The 1-lb rate of barban caused no visible injury to potatoes, cucumbers, carrots, table and sugar beets, or commercial yellow mustard; very slight injury to peas, beans, barley, and sunflower; slight to moderate injury to Redwood flax and Golden Seneca corn; and moderate injury to Thatcher wheat, showing up as slight growth delay. In a treatment made on a solid seeding of wheat, wild oat growth suppression was superior for a ½-lb rate, undoubtedly because of better crop competition. (Canada Dept. of Agriculture, Research Station, Lethbridge, Alberta.)

Control of weeds in Burley tobacco with pre-emergence herbicides used before or after transplanting. Treepetch, P. and Freeman, J. F. Ky. 16 tobacco was transplanted in Maury silt loam soil at Lexington June 6, 1960. Fertilizer, 5-10-15 grade, 2000 lb/A, had been disked in previously. Single-row plots 3.5 x 47 ft were used with a buffer row between plots. Treatments were in a randomized block design with 4 replications. Pre-transplanting herbicide treatments were applied to the soil 2 days before transplanting—the incorporated (inc) treatments being cultivated into the soil with a rotary tiller. Post-transplanting treatments were applied June 15, the incorporated ones just before and surface ones just after cultivation of the crop with narrow shovels. Herbicides were applied broadcast—those after transplanting over the tobacco. Spray-type herbicides were applied in water at rate of 26 gal/A and the granular (G) ones were broadcast by hand. Rainfall of 0.50 in occurred 1 day after pre-transplanting treatments, an equal amount during the week following and more than 10 in during 2-wk period following post-transplanting treatments. Weeds were crabgrass, prickly sida, common morning glory and woodsorrel. On the uncultivated check there were 13.7 weeds/sq ft (11.2 grass + 2.5 broadleaf) when count was made June 10. Treatments are listed with the rates in lb/A, then the weed control and crop injury ratings (visual, 0-10 scale) for each, as of July 16. Pre-planting: EPTC 3 (inc), 9.4 and 1.4; trietazine 3, 7.7 and 1; trietazine (G) 3, 9.5 and 2.3.

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Post-transplanting: EPTC 1.5 (inc), 9.1 and 1.8; EPTC (inc). 8.9 and 3.3; EPTC (G) 3, 9.6 and 3.3; EPTC (G) 3 (inc), 9.9 and 2.4; trietazine 3, 9.6 and 2.4; trietazine (G) 3, 9.8 and 2.6; 2,6-dichlorobenzonitrile (Casoron) 2, 9.3 and 1.8; 3, 8.6 and 2.9; 4, 9.5 and 1.8; 3 (inc), 9.4 and 3.4; Casoron (G) 3, 10 and 6; Casoron (G) 3, (inc), 9.8 and 9.3; amiben 4, 8.8 and 2.8; amiben (G) 10, 9.8 and 3.8; dimethyl 2,3,5,6-tetrachloroterephthalate (Dacthal) 4, 7.7 and 4.7; 8, 9.3 and 7; 12 9.5 and 8; and cultivated check 9.8 and 0.8. (Agronomy Dept., Kentucky Agr. Exp. Sta.)

Effect of weed control practices on the establishment of Vaughn side-oats grama. Wiese, A. F., and Hudspeth, E. B., Jr. Stand establishment of Vaughn side-oats grama (*Bouteloua curtipendula*) was compared in weed free, weedy, cultivated, and weedy sprayed plots. Six pounds of side-oats grama per acre were seeded in 40-inch rows on Pullman silty clay loam with the USDA F-63 grass drill on April 24, 1959. On May 27, when the grass was 2 inches tall, all treatments were established and the sprayed plots received butoxy ethanol ester of 2,4-D at ¼, ½, 1, and 4 lb/A. All treatments were replicated twice.

The four pound rate of 2,4-D caused slight leaf burning and prevented normal root growth. The predominant weed, rough pigweed, was controlled 100, 100, 75, and 25 percent, respectively by 4, 1, ½, and ¼ pounds of 2,4-D. In the fall of 1959, the weed free plots had 460 heads and the other treatments had less than 90 heads in 20 feet of row. In 1960 the grass stand was excellent on the weed free plots, good on the cultivated plots, and fair on the sprayed plots. This indicates that the few grass weeds, rescue grass, and little barley, not killed before planting, were as detrimental to grass establishment as the pigweed which emerged after seeding.

In May, 1960, weed free plots of Vaughn side-oats grama were treated with ¼, ½, and 1 lb/A propylene glycol butyl ether ester of 2,4-D when the grass was 3 inches tall, 8 inches tall, in the boot stage, and fully headed. Observations in October indicate that the treatments did not affect maturity, forage production, or seed production. (Contribution from the Texas Agr. Exp. Sta. and Agr. Eng. Research Division, ARS, USDA. Approved as TAES T.A. 3651.)

WEED CONTROL IN HORTICULTURAL CROPS

VEGETABLES

Pre- and post-emergence herbicidal treatments for carrots on muck soil. Chambers, Everett, and Holm, LeRoy. Pre-emergence. Red-cored Chantenay carrots were planted on 1 June 1960 in a muck soil at Madison, Wisconsin. The principal weeds in the area were purslane and rough pigweed. The following treatments (rates, lb/A) were made on 4 June: amiben, 6; 9S4 (2-dimethylamino-1,4-naphthoquinone) 4; Amizine (amitrole 15% plus simazine 45%), 3; ipazine, 4 and 6; GC 6691 (3-(3,4-dichlorophenyl)-1,1-dimethylurea trichloroacetate, 3; simazine, 2; and Randox T (CDAA plus trichlorobenzyl chloride), 4. Each treatment consisted of two 20 ft rows and was replicated 4 times. The weather remained warm and sunny following the application of the herbicides. The first rain fell 8 days after treatment. Stand counts were taken 23 June, weed counts 29 June, and harvest weights 24 August. The only appreciable injury to the carrots was caused by Randox T, which practically eliminated them. Per cent of weed control was as follows: amiben, 80, 9S4, 10, Amazine, 62, ipazine 4, 80, ipazine 6 95, GC 6691, 65, simazine, 78 and Randox T, 90. Ten percent granular formulations of amiben, simazine and Randox T were used at comparable rates and provided 10% less weed control than the liquid formulations.

Post-emergence. Adjacent to this area post-emergence trials were conducted with carrots planted on the same date. Herbicides were applied 20 June; a cloudy, humid day. Carrots had their first true leaves and the weeds were 1 in. tall. Rates (in lb/A) were as follows: Dicryl (*N*-(3,4-dichlorophenyl) methacrylamide), 4; Karsil (*N*-(3,4-dichlorophenyl)-2-methylpentanamide) 2 and 4; trietazine, 4; Stoddard solvent, 80 gpa; amiben, 6; Randox T, 4; ipazine, 4; and R 2061 (propylethyl-n-butylthiolcarbamate), 5. Weed control in per cent was as follows: Dicryl, 96; Karsil 2, 93; 4, 97; trietazine, 94; Stoddard solvent, 97; amiben, 60; Randox T, 70; ipazine, 96; R 2061, 40. The only herbicides which appeared injurious to the carrots were ipazine (20%), Randox T (20%), and trietazine (10%). (Contribution from the Dept. of Horticulture, Wisconsin Agr. Exp. Sta., Madison.)

Pre- and post-emergence herbicidal treatments for onions on muck soil. Chambers, Everett, and Holm, LeRoy. Pre-emergence. Danver's Yellow Globe onions were planted on 1 June 1960 in a muck soil at Madison, Wisconsin. The principal weeds in the area were purslane, and rough pigweed. The following treatments (rates in lb/A) were made on 4 June: Randox T (a mixture of CDAA and trichlorobenzyl chloride), 4; CDAA, 4; Zytron (*O*-2,4-dichlorophenyl *O*-methyl isopropylphosphoramidothioate), 8; amiben, 6; CIPC, 4, plus monuron, 1; 9S4 (2-dimethylamino-1,4-naphthoquinone), 4; CDEC 4; and Amizine (amitrole 15% plus simazine 45%), 3. A treatment consisted of two 20 ft rows. Each treatment was replicated 4 times. The weather remained warm and sunny following the application of the herbicides. The first rain fell 8 days after treatment. Stand counts were taken 23 June, weed counts 29 June, and harvest weights 24 August. The only injuries to onions were by amiben and Amizine which reduced yields by 50 and 20% respectively. The per cent of weed control was as follows: Randox T, 83; CDAA, 85; CIPC plus monuron 47; amiben, 85; CDEC, 78; Amizine, 62. Zytron and 9S4 gave no control. Zytron, Randon T, and amiben were also applied and in granular form at comparable rates and weed control from the two latter herbicides was 10% less than with emulsifiable formulations.

Post-emergence. In an adjacent area post-emergence trials were conducted with onions planted on the same date. Herbicides and rates in lb/A were as follows: Dicryl (*N*-(3,4-dichlorophenyl)-methacrylamide) 4; Karsil (*N*-(3,4-dichlorophenyl)-2-methylpentanamide), 2 and 4; trietazine, 4; CIPC, 8 mixed with diethanolamine salt of 2,4-D, ½; atrazine, 2; Randox T, 4; and R-2061 (propyl ethyl-*n*-butylthiolcarbamate) 5. They were applied 20 June; a cloudy, humid day. The onions were in the 2nd leaf stage and the weeds were about 1 inch tall. Trietazine reduced the yield 35%, R 2061, 15%, and Randox T, 25%. All other herbicides practically eliminated the onions. Per cents of reduction in weed stands were: Dicryl, 84; Karsil 2, 94; Karsil 4, 98; trietazine, 98; CIPC with 2,4-D, 98; atrazine, 99; R 2061, 26; and Randox T, 69. (Contribution from the Dept. of Horticulture, Wisconsin Agr. Exp. Sta., Madison.)

Pre-emergence weed control in carrots grown on a silt loam, 1960. Dinkel, D. H. Royal Chantenay carrots seeded ½" deep in silt loam on May 16 were sprayed May 24 with the following herbicides (rates, lb/A): 3 and 6 *N*-(3,4-dichlorophenyl)methacrylamide (Dicryl); 4 and 6 *N*-(3-chloro-4-methylphenyl)-2-methylpentanamide (Solan), 3 and 6 *N*-(3,4-dichlorophenyl-2-methylpentanamide (Karsil), 10 dimethyl tetrachloroterephthalate (Dacthal; 5 and 10 *O*-(2,4-dichlorophenyl) *O*-methyl isopropylphosphoramidothioate (Zytron); 3 and 6 amiben; 5 and 10 CIPC; and mixtures of some of these herbicides. Herbicides were applied to plots 18" by 18' in each of five replicates at 30 psi pressure in 40 gpa of water. The temp at the time of herbicide application was 77°F, the soil surface was moist and the first rain occurred 2 days after spraying on May 26 when .11" rainfall was recorded, followed by .06" on May 27, .59" on May 28 and .43" on May 29. The daytime temp for the week following herbicide application averaged 68°F. Weeds, consisting of *Chenopodium album, Sper-*

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gula arvensis, Thlaspi arvense, Stellaria media, Capsella bursa-pastoris, Brassica arvensis and other miscellaneous broadleaved weeds, were emerging at the time of herbicide application. Four and 6 lb/A Solan, 3 and 6 lb Karsil, 3 and 6 lb Dicryl and mixtures with these herbicides gave 100 percent weed control for more than 4 weeks following application without injury to carrots. Only 6 lb amiben injured carrots significantly. All other herbicides gave unsatisfactory weed control and did not injure carrots. (Contribution from the Alaska Agr. Exp. Sta., Palmer.)

Post-emergence weed control in carrots grown in silt loam. Dinkel, D. H. Royal Chantenay carrots seeded ½" deep in silt loam on May 16 were sprayed June 6 with the following herbicides (rates lb/A): 3 and 6 *N*-(3,4-dichlorophenyl)methacrylamide (Dicryl); 4 and 6 *N*-(3-chloro-4-methylphenyl)-2-methylpentanamide (Solan); 3 and 6 lb *N*-(3,4-dichlorophenyl)-2-methylpentanamide (Karsil); 10 dimethyl tetrachloroterephthalate (Dacthal); 5 and 10 *O*-(2,4-dichlorophenyl) *O*-methyl isopropylphosphoramidothioate (Zytron); 3 and 6 amiben; 5 and 10 CIPC; 140 gpa Stoddard solvent; and mixtures of some of these herbicides. All herbicides except Stoddard solvent (applied at 140 gpa) were applied at 30 psi pressure in 40 gpa water to plots 18" by 18' in each of five replicates. The temp at the time of herbicide application was 72°F, the soil surface was dry and no rainfall was recorded during the week following herbicide application. The daytime temp for the week following application averaged 65°F. Weeds consisted of *Chenopodium album, Spergula arvensis, Thlaspi arvense, Stellaria media, Capsella bursa-pastoris, Brassica arvensis* and other miscellaneous broadleaved weeds. Three and 6 lb/A Karsil, 4 and 6 lb. Solan, mixtures with these herbicides and 6 lb Dicryl plus 5 lb CIPC gave 100 percent weed control throughout the season without injury to the carrots. Stoddard solvent at 140 gpa gave 100 percent control of weeds for two weeks following application but it was necessary to hand weed after June 28. All other herbicides gave unsatisfactory weed control and did not injure carrots. (Contribution from the Alaska Agr. Exp. Sta., Palmer.

Pre-emergence weed control in four vegetable crops on muck soil. 1960. Nelson, D. C., Weaver, M. L., and Nylund, R. E. King Red beets, Danish Ballhead cabbage, Nantes carrots, and Trapp's Downing Yellow Globe onions were seeded May 3 in muck soil with a pH of 6.2 and the following herbicides applied on May 12: propazine, ipazine, amiben, CDAA, CDAA-T(29% CDAA plus 71% trichlorobenzyl chloride), dimethyl 2,3,5,6-tetrachloroterephthalate (Dacthal), *O*-2,4-dichlorophenyl *O*-methyl isopropylphosphoramidothioate (Zytron), and 2-methoxy-3,6-dichlorobenzoic acid (Velsicol B). All herbicides were applied with a variable dosage sprayer at 30 psi pressure in 74 gpa of water to duplicated plots. Each plot consisted of four 110' rows (single rows of each crop) seeded 12" apart; every third plot was an untreated check. Rains following spraying occurred May 16, .28", May 19, .69", May 20, 1.05", and May 21, 2.02". Weed control and crop injury ratings were taken four weeks after spraying. Weeds in the check plots consisted of *Amaranthus* spp., *Portulaca oleracea, Capsella bursa-pastoris, Polygonum* spp., *Setaria* spp. and *Echinochloa crusgalli*. The following gives the herbicides which showed promising selectivity (the lower figures the minimum rate which gave satisfactory weed control; the higher figures, the maximum rate which gave no crop injury): for beets, none; for cabbage, ½-1½ lb/A amiben, 2-7 lb/A CDAA-T, 3-4 lb/A CDAA, and 6-11 lb/A Zytron; for carrots, ½-3 lb/A amiben, 4-6 lb/A Dacthal, 1-5 lb/A propazine, and 6-10 lb/A Zytron. Velsicol B showed little or no selectivity for the crops tested. (Paper No. 4488 of the Minnesota Agr. Exp. Sta.)

Pre-emergence weed control in lima beans 1960. Nelson, D. C., Weaver, M. L. and Nylund, R. E. Early Throughgreen lima beans seeded on July 17 in a clay loam soil were sprayed three days after planting with the following herbicides (rates, lb/A): 4 CDAA, 11 and 14 CDAA-T (29% CDAA plus 71% trichlorobenzyl chloride), 6 CIPC, 6 and 9 DNBP, 2 and 4 amiben, 2 diuron, 6 DNBP + 2 amiben, and 6 DNBP + 11 CDAA-T. Plots were single 22' rows, replicated four times. Herbicides were applied at 30 psi pressure in 80 gpa of water. At the time of herbicide application the soil surface was wet and no weeds or beans had emerged. Rains following application, on June 20, occurred on June 21, .15", June 22, .54", and June 23, 1.32". Weed control and bean injury ratings were taken four weeks after spraying. At that time weeds in the check plots consisted principally of *Amaranthus retroflexus, Setaria lutescens*, and lesser numbers of *Chenopodium album, Ambrosia artemisiifolia, Echinochloa crusgalli* and *Setaria viridis*. Satisfactory control (85-100%) of broadleaved and grassy weeds was obtained with 2 and 4 lb/A amiben. Only one herbicide, 11 and 14 lb/A CDAA-T, injured beans. (Paper No. 4493 of the Scientific Journal Series of the Minnesota Agr. Exp. Sta.)

Pre-emergence weed control in four vegetable crops on mineral soil, 1960. Nelson, D. C., Weaver, M. L. and Nylund, R. E. Topcrop snap beans, Straight Eight cucumbers, Perfection Freezer peas, and Golden Delicious squash were seeded May 23 with the following herbicides: 6-nitro-2,4,dichlorophenol (O.M. 1306), dimethyl 2,3,5,6-tetrachloroterephthalate (Dacthal), amiben, *O*-2,4-dichlorophenyl *O*-methyl isopropylphosphoramidothioate (Zytron), CDAA-T (29% CDAA plus 71% trichlorobenzyl chloride), CDAA, and trietazine. All herbicides were applied to a moist soil with a variable dosage sprayer at 30 psi pressure in 74 gpa of water to each of two replicates. Each plot consisted of four 110' rows (single rows of each crop) seeded 12" apart; every third plot was an untreated check. Rains following spraying occurred May 26, .35", May 27, .10", June 3, .05", and June 10, .30". Weed control and crop injury ratings were taken three weeks after spraying. Weeds in the check plots consisted principally of mustard *(Brassica hirta)*, millet *(Setaria italica)*, and pigweed *(Amaranthus spp.)* all of which had been broadcast immediately after soil preparation. The following gives the herbicides which showed promising selectivity (the lower figures, the minimum rate which gave satisfactory weed control; the higher figures, the maximum rate which gave no crop injury): for snap beans, 2-4 lb/A amiben and 4-15 lb/A Zytron; for cucumbers none; for peas 2-4 lb/A amiben, 4-6 lb/A Zytron, 3-6 lb/A CDAA; for squash 2-5 lb/A amiben, 4-15 lb/A Zytron, and 3-7 lb/A CDAA. The following herbicides showed little or no selectivity for the crops tested: O.M. 1306, Dacthal, CDAA-T, and trietazine. (Paper No. 4489 of the Scientific Journal Series of the Minnesota Agr. Exp. Sta.)

Pre-emergence weed control in onions grown on muck, 1960. Nelson, D. C. Weaver, M. L. and Nylund, R. E. On May 5 Trapp's Downing Yellow Globe onions were seeded ½", 1" and 1½" deep in muck soil having a pH of 7.0. The following herbicides were applied on May 10 both as sprays and as granular materials: 8 lb/A CIPC, 1 and 2 lb/A diuron, 6 lb/A CDAA, and 11 and 22 lb/A CDAA-T (29% CDAA plus 71% trichlorobenzyl chloride). In addition 1 and 2 lb/A monuron and 3 lb/A amiben were applied as sprays. Herbicides were applied to plots 4' x 22' and replicated four times. Sprays were applied at 25 psi in 60 gpa of water. On the date of application the temp was 54°F, humidity 50%, soil surface wet and no weeds or onions had emerged. Rainfall during the two weeks following application was May 15, .75", May 18, .50", May 19 .20", May 20, .60", and May 21, 1.25". Weed control was rated on June 14; plots were harvested on September 8. Weed populations in check plots contained 70% *Amaranthus* spp., 10% *Polygonum* spp., 10% *Ambrosia artemisiifolia* and 10% annual grasses. Sprays generally gave slightly better weed control than graular forms of the herbicides tested. One herbicide, 11 and 22 lb/A CDAA-T, gave satisfactory weed control (85-100%) without reducing onion yields. The following herbicides gave satisfactory weed control but reduced onion yields by the indicated percent: 1 lb/A diuron (liquid) 18%, 1 lb/A diuron (granular) 16%, 2 lb/A diuron (liquid) 73%, 2 lb/A diuron (granu-

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lar) 23%, 1 lb/A monuron 36%, 2 lb/A monuron 74% and 3 lb/A amiben 25%. The reductions in yield were primarily due to reduced stands of onions. Injury to onions from herbicides was equal at all depths of seeding. (Paper No. 4492 of the Scientific Journal Series of the Minnesota Agr. Exp. Sta.)

Early post-emergence weed control in onions grown on muck, 1960. Nelson, D. C., Weaver, M. L. and Nylund, R. E. One May 5 Trapp's Downing Yellow Globe onions were seeded in muck soil having a pH of 7.0. The following herbicides were applied on May 27 both as sprays and as granular materials: 8 lb/A CIPC, 1 and 2 lb/A diuron, 6 lb/A CDAA, and 11 and 22 lb/A CDAA-T (29% CDAA plus 71% trichlorobenzyl chloride). In addition 1 and 2 lb/A monuron were applied as sprays and 3 lb/A amiben as a granular material. Herbicides were applied to plots 4′ x 22′ and replicated four times. Sprays were applied at 25 psi in 60 gpa of water. On the date of application the temperature was 54°F., humidity 88%, soil surface wet, weeds were in the cotyledon stage and onions in the late loop to early flag stage. Rainfall during the two weeks following application was May 29, .50″, June 1, .22″, and June 4, .12″. Weed control was rated on June 22; plots were harvested on September 8. Weed populations in control plots consisted of 60% *Amaranthus* spp., 15% *Polygonum persicaria*, 10% *Portulaca oleracea*, and 15% annual grasses. Sprayed and granular herbicides gave equally good weed control. The following herbicides gave satisfactory weed control (85-100%) without reducing the yield of onions: 6 lb/A CDAA (spray and granular), 11 lb/A CDAA-T (spray and granular), 22 lb/A CDAA-T (granular), 8 lb/A CIPC (granular), and 3 lb/A amiben (granular). Herbicides giving satisfactory weed control, but reducing yields of onions were (with percent yield reduction): 22 lb/A CDAA-T (spray), 25%, 8 lb/A CIPC (spray), 23%, 1 lb/A diuron (spray), 91% 1 lb/A diuron (granular), 68%, 2 lb/A diuron (spray), 99%, 2 lb/A diuron (granular), 64%, 1 lb/A monuron, 68%, and 2 lb/A monuron, 94%. The reductions in yield were primarily due to reduced stands of onions. (Paper No. 4491 of the Scientific Journal Series of the Minnesota Agr. Exp. Sta.)

Late post-emergence weed control in onions grown on muck, 1960. Nelson, D. C., Weaver, M. L., and Nylund, R. E. On May 5 Trapp's Downing Yellow Globe onions were seeded in muck soil with a pH of 7.0. The following herbicides were applied on July 20 both as sprays and as granular materials (rates, lb/A): 8 CIPC, 1 and 2 diuron, and 11 and 22 CDAA-T (29% CDAA plus 71% trichlorobenzyl chloride). In addition the following herbicides were applied as sprays: 10 EXD, 8 CIPC + 10 EXD, and 8 CIPC + 5 EXD. Herbicides were applied to plots 4′ x 22′ and replicated four times. Sprays were applied as basal sprays at 25 psi pressure in 60 gpa of water. At the time of application the temperature was 88°F., humidity 42%, and the soil surface was dry. At this time onions had 9 leaves, and weeds consisted of 90% *Portulaca oleracea* in the seedling to 3″ mat stage. Rainfall during the two weeks following application was July 24, .09″, July 29, .25″, August 2, .04″, and August 3, .05″. Weed control was rated on August 3, plots were harvested September 8. Sprays gave definitely better weed control than granular materials, but only one herbicide, 1 and 2 lb/A diuron (spray) gave satisfactory weed control. None of the herbicides reduced yields or stands of onions. (Paper No. 4487 of the Scientific Journal Series of the Minnesota Agr. Exp. Sta.)

FRUIT

The eradication of quackgrass adjacent to young cherry trees. Holm, LeRoy and Gilbert, Frank. Low levels of simazine and diuron (2 to 3 lb/A) may be used to control weeds around newly-planted apple and cherry trees. If the soil has been reasonably well prepared, it is likely that annual applications of such herbicides may give complete control or satisfactory suppression of weeds in most situations. When trees are ten years or more in age, higher rates of these herbicides (10 to 20 lb/A) have been used for long periods without injury when the spray is confined to an area 6 to 8 feet in diameter around the trunk. These treatments destroy all vegetation and eliminate rodent cover. There is one point in our system of management at which we have no satisfactory chemical method for weed control. This is the problem which presents itself when a newly-planted tree site or orchard has been allowed to become weed-infested while the trees are still young and before they are of bearing age. The experiments described here are concerned with the search for a chemical treatment which may be used to kill annual weeds, quackgrass, and other perennial weeds around young trees. If successful treatments may be found, the area may then be clean-cultivated to remove and bury the trash, and the program of weed control with diuron or simazine (as described previously) may be initiated.

Since 1955 many chemicals and fumigants have been tried in dirty orchard sites both with and without the presence of young fruit trees. The principal weed in all of the experiments has been quackgrass. The most promising herbicides were brought together in the experiment reported here. It was begun on June 10, 1960, on a sandy loam soil in an orchard of 5 yr old trees near Sturgeon Bay, Wisconsin. The quackgrass stands, which were very heavy, were established by inoculation with rhizomes in 1958. Two replications were used and the herbicides were placed in a circular area of 30 sq ft at the base of each tree. Rates given are in lb/A except for SMDC. Sodium arsenite 15, DMTT 300, amitrole-T 20, atrazine 5, prometone 12, Amizine (amitrole 15% plus simazine 45%) 10, GC 6691 (3-(3,4-dichlorophenyl)-1,1-dimethylurea trichloroacetate) 3, and SMDC at 300cc per 30 sq ft, were used alone. Atrazine 5 was used in mixtures with sodium arsenite 15, DMTT 300, and amitrole-T 20. SMDC at 200cc per 30 sq ft was used in mixtures with prometone 12 and with amitrole-T 10. DMTT 300 was mixed with sodium arsenite 15 and with amitrole-T 10. Black plastic was also used as a treatment. In those plots where the drench fumigants SMDC and DMTT were used, the chemicals were sealed in with 3 gal water per 30 sq ft.

Growth of grass in most plots was stopped almost immediately and the treated areas were brown for most of the season. On October 20, black plastic and the following herbicides were still showing perfect control or had less than 5% regrowth: Amizine 10, atrazine 5, prometone 12, atrazine 5 with sodium arsenite 15, atrazine 5 with DMTT 300, prometone 12 with SMDC at 200cc per 30 sq ft, and atrazine 5 with amitrole-T 20. The following were showing 15-20% regrowth: amitrole-T 20, SMDC at 300cc per 30 sq ft, DMTT 300, DMTT 300 with amitrole-T 10, and amitrole-T 10 with SMDC at 200cc per 30 sq ft. All other treatments gave poor weed control. The only injury was caused by the fumigants as follows: one tree treated with DMTT plus atrazine, and another treated with SMDC plus amitrole-T were severely injured and may have been killed; a tree was injured in the area treated with SMDC alone. Atrazine, Amizine, prometone, and amitrole appear to be promising herbicides for this purpose. (Contribution from the Department of Horticulture, Wisconsin Agr. Exp. Sta., Madison.)

TURF

Effect of dextrorotatory isomer of 4-chloro-2-methyl phenoxypropionic acid (Compitox) on chickweed. Corns, Wm. G. In separate replicated experiments common chickweed, long stalked chickweed, and field chickweed growing in well established lawn turf were sprayed in mid-June with 18 and 24 oz/A in 40 gal/A water. Two weeks after spraying 90-98% of the treated common chickweed was killed. By mid-August there was extensive re-infestation arising partially from residual crowns, but apparently mainly from new seedlings.

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Long-stalked chickweed died more slowly and by mid-August there was more than 95% control with no appreciable re-infestation later. Field chickweed was thinned but was not as susceptible as the other species. The lower rate gave about 55% control; the higher rate about 70% control by fall 1960. Both rates caused temporary browning of some of the grass leaves. In a supplementary test in August on a lawn started only three months earlier these rates of chemical caused more pronounced, but apparently not permanent injury to the fescue and blue grass observed in September. (Division of Crop Ecology, Dept. of Plant Science, Univ. of Alberta.)

Response of arrow grass and marsh reedgrass to herbicide sprays. Corns, Wm. G. Replicated 100 sq ft plots of the species in mixture in a wet meadow were sprayed on June 8, 1959. The rates were: dalapon and TCA, 30, 60, and 120 lb/A; fenac sodium salt and wettable powder, butoxy ethanol ester of 2,4-D, isooctyl ester of 2,4,5-T, and propylene glycol butyl ether ester of silvex, all at 1, 2, and 4 lb/A. By September 1959, dalapon at all rates had caused severe injury to both species. TCA at 120 lb/A and 2,4-D ester at 2 to 4 lb/A had caused moderate to severe injury to both species. Fenac, silvex, and 2,4,5-T had little effect. Before the fall of 1960 the arrow grass had recovered in all plots and the marsh reedgrass also was re-established except in the plots treated with 60 and 120 lb dalapon/A (70-95% control) and in one plot treated with 120 lb TCA/A. (Division of Crop Ecology, Dept. of Plant Science, Univ. of Alberta.)

Response of arrow grass and marsh reedgrass to granular herbicides. Corns, Wm. G. Duplicate 100 sq ft plots of mixed arrow grass and reedgrass in a wet meadow were used for each treatment on July 14, 1959. The rates (active ingredients) were 4, 8, 16 lb/A from granular 2,4-D acid, fenac pellets, and granular silvex, and 30, 60, 120 lb/A from dalapon pellets. A year later there was no visible decrease in arrow grass in any of the plots. Marsh reedgrass, however, appeared to be killed by the high rate of dalapon and of granular 2,4-D. Fenac pellets caused an intermediate response. There was no appreciable effect of silvex. The apparent susceptibility of marsh reedgrass to the relatively small amounts of granular 2,4-D encourages further attention. (Division of Crop Ecology, Dept. of Plant Science, Univ. of Alberta.)

Soil fumigants for weed control in lawns, 1960. Selleck, G. W. A weedy lawn was treated with methyl bromide 98%, chloropicrin 2% (Dowfume MC-2) at a rate of 1 lb/100 sq ft. applied beneath a plastic tarpaulin and SMDC (Vapam) at a rate of 20 oz/100 sq ft in 4 gal water (applied with a sprinkling can) on sandy loam soil as Saskatoon, Sask., August 5, 1959. The plastic tarpaulin was maintained over the Dowfume for 48 hours at daily temperatures from 70° to 80° F. Rain fell immediately after the application of Vapam so that irrigation water was not needed for a seal. Merion bluegrass was seeded to Dowfume treated areas 3 days after application, and to Vapam treated plots after 7 days. Bluegrass germinated satisfactorily, and established stands of couchgrass were killed by both herbicides. Seeds of broad-leaved or grassy weeds did not greminate during 1959, but buckwheat seedlings were evident on the Vapam plots May, 1960. (Contribution No. 301 from the Dept. of Plant Ecology, Univ. of Saskatchewan, Saskatoon, with financial assistance from the Sask. Agric. Research Foundation.)

FORESTRY, ORNAMENTAL NURSERIES AND SHELTERBELTS

Effect of atrazine on seed germination and subsequent growth of young pine seedlings. Kozlowski, T. T. and Kuntz, J. E. In nursery plantings, coniferous seedlings of different ages have reacted differently to triazine herbicides. Therefore, atrazine at 1, 2, and 4 lb/A was sprayed on replicated flats of Plainfield sand, previously sown with red pine seed. Seeds germinated normally; all seedlings emerged after 3 weeks. Shortly, however, needle chlorosis, curling and dieback developed, increasing in severity with time (50% mortality). Post-emergence treatments of the same dosages were applied to young pine seedlings and to emerging white pine seedlings, growing in flats of Plainfield sand and composted greenhouse soil. Phytotoxic effects developed more rapidly and to a greater degree on red pine than on white pine seedlings, and especially on composted soil. Injury increased with dosage and time after treatment. Severe phytotoxicity to oats planted at intervals thereafter demonstrated that atrazine remained in the upper soil layers for at least 3 months and caused growth depression even when soils had been leached with 16 surface inches of water. (Contribution of the Wisconsin Agr. Exp. Sta. in cooperation with the Wisconsin Conservation Dept. and the Geigy Chemical Corp.)

Chemical weed control in forest plantings. Kuntz, J. E., Kozlowski, T. T., Hovind, J., and Bloomquist, W. The survival and subsequent growth of young forest plantings are severely limited by weed and especially grass competition, particularly during the first year or two. Weed control by mechanical means has certain limitations. Since 1948, many herbicides at different concentrations and in various combinations have been tested in plantings of cottonwood cuttings and red pine transplants on both prepared and non-prepared sites of Plainfield sand and various loam soils. On heavier soils, monuron and diuron at 2 lb/A have generally given satisfactory first-season weed control with little injury to trees. Results with simazine and atrazine at 3 and 6 lb/A and on different sites have varied: generally, satisfactory first-season weed control, increased tree survival, and only occasional injury to trees. Dalapon at 5 to 10 lb/A, alone and in combination, sprayed so as to avoid tree foliage, also has given promising results. (Contributions of the Wisconsin Agr. Exp. Sta. in cooperation with the Wisconsin Conservation Dept., the Nekoosa-Edwards Paper Company, and several chemical companies).

Oak wilt control with soil fumigants. Kuntz, J. E. and Riker, A. J. Control of the spread of the oak wilt fungus, *Ceratocystis fagacearum* (Bretz) Hunt, from an infected tree to adjacent healthy trees through underground root grafts has been achieved either (1) by poisoning adjacent healthy trees with sodium arsenite or (2) by cutting roots between trees. In experiments since 1956, soil injections with methyl bromide or SMDC (Vapam) have killed portions of roots of oak trees (*Quercus ellipsoidalis*, 5 to 8 in. dbh) growing in the deep, porous Plainfield sand of central Wisconsin. Herbicides were injected into approximately 1½ in. holes placed between trees in a single line at 1 ft. intervals. The holes were made in succession to depths of 1½, 2, 2½, and 3 ft. One pound of methyl bromide treated 5, 10, 15 or 20 linear feet. Vapam (formulation), diluted 1 to 10 with water, was used at rates of 50, 100, 200, and 400 ml per hole. Root kill was excellent at all dosages although less injury occurred to nearby trees and ground cover at the lower rates. After af ew days dyes and poisons did not pass through the killed parts of roots because tyloses rapidly plugged the xylem vessels at the margins of the killed root sectors. In plots with artificially inoculated trees, oak wilt did not develop across fumigated strips. (Contribution of the Wisconsin Agr. Exp. Sta. in cooperation with the Wisconsin Conservation Dept. and the Nekoosa-Edwards Paper Company.)

Grass control under trees. McCurdy, E. V. In an attempt to eradicate a mixed stand of crested wheat grass and Kentucky blue grass growing under ash trees herbicides have been applied once to each plot since 1957. TCA was applied at 20, 40, 60, 80 and 100 lb/A. At rates high enough to control the grass, (above 40 lb/A) the

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trees were severely injured. Some were still showing weak regrowth in 1960 but others were dead. Results with 15 and 20 lb/A rates of dalapon during the past 3-year period have been variable. In some years injury has occurred at 15 lb/A and has been quite general at 20 lb/A. Some injury was noted this year when dalapon was applied at 15 lb/A plus amitrol at 4 pounds but grass was well controlled. Amitrol at rates of 4 to 12 pounds and amitrol-T at 6 lb/A have not injured the trees but grass has not been effectively controlled. Amizine at 5 to 9 lb/A caused injury to some trees whereas others appeared normal. At the light rate the grass was not controlled. Based on the past experience, none of these herbicides appears very promising for grass control under ash trees. (Contributed by the Experimental Farm, Indian Head, Saskatchewan.)

Soil sterilants for couch grass control in spruce, 1960. Selleck, G. W. Simazine and atrazine at 20, 30 and 40 lb/100 sq ft and dalapon at 60 and 80 lb/100 sq ft in 2 gal water were applied to couch grass and brome grass in spruce to duplicated plots on silty clay loam soil near Saskatoon, April 29, 1959. Grasses were in the 3-leaf stage. All plots were located between 2 and 4 ft from spruce trees. Second applications of simazine and the 20 lb rate of atrazine were made August 28, 1959. The percentage control in July, 1959 and May, 1960 are presented in the following table.

Herbicide	No. of applications	Rate lb/100 sq ft	Percent control July 1959	Percent control May 1960
Simazine	2	20	2	60
Simazine	2	30	35	85
Simazine	2	40	50	95
Atrazine	2	20	75	97
Atrazine	1	30	95	100
Atrazine	1	40	87	97
Dalapon	1	60	90	80
Dalapon	1	80	100	99

Atrazine at 30 lb damaged the spruce where the herbicide was sprayed adjacent to the trunk. Where a 2 ft distance was maintained, damage was not noticeable for any of the other treatments. (Contribution No. 300 from the Dept. of Plant Ecology, Univ. of Saskatchewan, with financial assistance from the Sask Agric. Research Foundation.)

Effects of herbicides on red pine seedlings and transplants. Winget, C. H., Kozlowski, T. T., and Kuntz, J. E. The high cost of hand weeding has led to investigations of chemical weed control in forest nurseries. In 1960, the effects of a number of herbicides on the growth of three age classes of red pine seedlings were evaluated. In Griffith State Forest Nursery in central Wisconsin, which is located on Plainfield sand, experiments of a randomized block design using ¼ milacre plots were established in standard nursery beds. The herbicides were applied with trombone sprayers as water emulsions or suspensions after the new shoots of seedlings began to harden off in June. The following herbicides were compared with untreated checks: atrazine; simazine; propazine; 2-chloro-4-isopropylamino-6-methylamino-*s*-triazine (G-30026); simetone; NPA; sesone; CDAA; CDEC; and EPTC. Soil moisture was maintained with an overhead irrigation system. Herbicide damage and mortality of seedlings were recorded. The plots were sampled in late August and the oven-dry weights of weeds and seedlings per plot were determined. Analysis of the data indicated that EPTC, CDEC, and propazine combined the most effective weed control with the least adverse effect on seedlings. It was found that older seedlings were less affected than younger ones by any of the herbicides tested. (Depts. of Forestry and Wildlife Management and of Plant Pathology, Univ. of Wisconsin in cooperation with Wisconsin Conservation Dept.)

BASIC STUDIES

Effects of feeding herbicides to honey bees. King, Charles C. One-week-old adult honey bees confined in cages were fed sugar solutions containing sodium salt of 2,4-D, sodium salt of 2,4,5-T, sodium salt of 4-(2,4-DB), technical amitrole, alkanolamine salts of DNBP, alkanolamine salts of MCPA, dalapon, and TCA, at 6400, 1600, 400, 100, and 25 ppmw. The mortality rate, recorded daily for 33 days following treatments is presented in the following table.

Toxicity of herbicides in sugar solutions fed to one-week-old adult honey bees. 1 = very toxic, 2 = moderately toxic, 3 = slightly toxic, and 4 = non-toxic.

Herbicide	Rate active ingredient, ppmw 6400	1600	400	100	25
2,4-D	1	3	4	4	4
2,4,5-T	1	1	4	4	4
4-(2,4-DB)	1	3	4	4	4
Amitrole	1	1	1	2	2
DNBP	1	1	1	1	2
MCPA	1	1	4	4	4
Dalapon	3	4	4	4	4
TCA	2	3	4	4	4

A similar experiment was conducted using sodium salt of 2,4-D and technical amitrole fed in sugar solution to bees obtained directly from the hive. The age of the bees could not be accurately determined, but they appeared to be about 2 to 4 weeks older than those used in the experiment mentioned above. The results, presented in the following table, indicate that the older bees apparently were more resistant than the one-week-old bees to amitrole. Little or no difference in response to 2,4-D occurred.

Toxicity* to "hive" bees

Herbicide	Rate active ingredient, ppmw 10000	5000	2500	1000	500	250	125
2,4-D	1	1	1	2	3	4	4
Amitrole	2	2	3	3	3	3	4

*Toxicity rating same as in preceding table.

In another experiment, quadruplicate colonies of Island Hybrid bees were supplied with 4 gal of sugar syrup containing sodium salt of 2,4-D and technical amitrole each at 250 ppmw on July 25, 1960. Three colonies supplied with sugar syrup only served as checks. The syrup was utilized by each colony by September 9, 1960. The net weight of each colony was recorded weekly from May 20, 1960 through October 7. The weight of each hive increased at approximately the same rate, indicating little or no apparent detrimental effect by the 2,4-D or amitrole. (Ohio Agr. Exp. Sta.)

Translocation of C^{14}-2,4-D and C^{14}-amitrole or their metabolites to nectar in plants. King, Charles C. In preliminary investigations, autograms of plants foliar treated by C^{14}-2,4-D and C^{14}-amitrole showed that radioactive material was present in the floral tissues. In order to determine whether the nectar of plants treated by these labeled herbicides contained radioactive material, additional plants were treated, their nectar placed on filter paper, desiccated and radioautographed.

Snapdragons having 2 to 4 florets when treated by C^{14}-amitrole (specific activity 0.95 mc/mM) at 2 μc per plant and harvested 2, 4, 6 and 8 days later contained radioactive material in this nectar of one or more florets on each plant. Radioautographs of red clover treated similarly by C^{14}-amitrole at 2 μc per plant at the bud stage and harvested at bloom showed considerable radioactive material in the nectar. However, the nectar of red clover plants treated at the full bloom stage contained no labeled material. The nectar of poinsettia

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plants treated by C^{14}-amitrole at 4 μc per plant contained radioactive material each day for 34 days following treatment, after which none was detected in the nectar. The nectar of the poinsettias was extracted each day from the same plants, whereas the nectar of the snapdragons and red clover was extracted each time from different plants.

The nectar of red clover plants treated by C^{14}-2,4-D (specific activity 1.0 mc/mM) at 2 μc per plant at the bloom stage contained considerable labeled material when harvested 3 days later, the only sampling date. The nectar of poinsettia plants treated by C^{14}-2,4-D at 4 μc per plant at the bloom stage contained labeled material when sampled 2 and 3 days later, the only sampling dates, but nectar secretion ceased usually within 6 days after treatment. (Ohio Agr. Exp. Sta.)

Effect of herbicides on the foraging activity of honey bees. King, Charles C. (Plots (25 ft^2) of alsike clover, Ladino clover, white sweetclover, smartweed and common milkweed at the full bloom stage were wet to point of runoff by each of the following in 100 gal of water: propylene glycol butyl ether (PGBE) ester of 2,4-D and PGBE ester of 2,4,5-T at 3 lb; dimethylamine salt of 4-(2,4-DB) and dimethylamine salt of 4-(MCPB) at 1½ lb; amitrole at 4 lb; alkanolamine salts of DNBP at 4½ lb; alkanolamine salts of MCPA at 2 lb; dalapon at 11¼ lb; and TCA at 12½ lb. The number of honey bees foraging in the treated and check plots was recorded periodically for 10 days following the treatments.

One hour after the applications, the first recording period, the honey bees avoided only the plots treated by DNBP, which they avoided the entire 10 days. Bee activity in all the clover and milkweed plots treated by 2,4-D, 2,4,5-T and MCPA ceased after 24 hours; by dalapon, 4 days; by amitrole, 6 days; and by TCA, 8 days. Foraging continued normally for the duration of the experiment in the clover plots treated by 4-(2,4-DB) and 4-(MCPB).

Foraging in the smartweed plots treated by DNBP ceased after 2 hours, the first recording period; by dalapon, 1 day; and by TCA, 2 days. Foraging in smartweed plots treated by 2,4-D, 2,4,5-T, 4-(2,4-DB), amitrole, 4-(MCPB) and MCPA continued throughout the experiment at about one-half the intensity observed in the check plots.

These data and the results with labeled herbicides, presented by the author above, indicate that honey bees may forage on plants that may contain herbicide residues or their metabolites in the pollen and nectar. (Ohio Agr. Exp. Sta.)

Effect of quackgrass and quackgrass residues on minerals available to alfalfa. Ohman, J. H., Lambert, R. G., and Kommedahl, T. Quackgrass was grown in competition with alfalfa on a root solution exchange apparatus (Lambert: Plant Disease Reporter 43:1117) which allows plants to utilize the same nutrient supply, but eliminates competition for light, water, and space. Toxic materials produced in root solutions by either species would be continuously transferred to the other species. Mineral solutions at 2 concentrations were added initially and weekly thereafter. Water levels were adjusted daily. Plants at the high concentration received 5 times more minerals than plants at the low concentration. Volumes of both concentrations were held constant to avoid dilution of a possible toxin. To study the effects of quackgrass residues, 15 gm of dried, ground rhizomes or a water leachate of 15 gm of rhizomes were added to autoclaved soil in 4-inch clay pots which were then sown with alfalfa. Some of the pots received 240 mg of ammonium nitrate initially. At the low mineral concentration the dry weight of alfalfa grown with quackgrass for 1 month was 68% less than alfalfa grown with alfalfa, and the dry weight of quackgrass was 17% greater than quackgrass grown with quackgrass. At the high mineral concentration alfalfa grown with quackgrass was not significantly different in dry weight from alfalfa grown with alfalfa. The dry weight of alfalfa grown 1 month in soil containing dried, ground rhizomes or water leachates from them was 75% less than alfalfa grown in soil only. Adding ammonium nitrate almost nullified the effect of residues or leachates, but had little effect when added to checks. While water leachates or quackgrass rhizomes are toxic to alfalfa seeds germinated on filter papers soaked in leachate, neither rhizomes nor leachates are harmful to alfalfa when added to soil if adequate nitrogen is available, and since no toxic material was detected in the root solution of live quackgrass, it is doubtful that directly toxic materials are ecologically important. The effects observed could be accounted for by the widening of the soil carbon to nitrogen ratio when residues are added to soil and by the greater ability of living quackgrass to compete for available minerals. (Contribution of Dept. of Plant Pathology and Botany, Institute of Agriculture, Univ. of Minnesota, St. Paul. Paper No. 4497, Scientific Journal Series, Minnesota Agr. Exp. Sta. Supported in part by The Rockefeller Foundation.)

Reproductive potential of yellow nutgrass. Tumbleson, M. E. and Kommedahl, T. Studies were made on the population of plants and tubers of yellow nutgrass on several peatlands in Minnesota. Peatland in truck crops at Maple Plain averaged 13 million plants and 38 million tubers per acre (85% of these tubers were in the upper 6 in. of soil); this is 9 tons (fresh weight) of tubers per acre of peat. On land fallowed for 4 years, 57,000 tubers were produced per acre. At Hollandale, in field crops on peat, nutgrass plants averaged about 800,000 per acre. At Rosemount on silt loam 1 tuber produced in 1 year 1900 plants and 6900 tubers to a 10 in depth in a patch 7 ft in diameter. One thousand tubers harvested in September at Hollandale germinated 12%, but 1000 tubers harvested from the same plots the next June germinated 95%. In Petri plates each tuber produced from 0 to 7 shoots with an average of 2. Shoots always arose from the distal end of the tuber. Tubers stored 4 weeks at 3°C increased from 78 to 132 plants per 100 tubers. Tubers planted in peat at 3 in. depths produced 70 plants per tuber while tubers planted 1½ in. deep gave 146 plants per tuber in 16 weeks in the field (St. Paul). Tubers planted in sand produced 31 plants per tuber while tubers in silt loam produced 129 plants per tuber in field trials. In the greenhouse with sandy silt loam, the number of shoots per 100 tubers planted at various depths was 95 at 2 in, 32 at 9 in, and 21 at 12 in. (Contribution of Dept. of Plant Pathology and Botany, Institute of Agriculture, Univ. of Minnesota, St. Paul 1. Paper No. 4503, Scientific Journal Series, Minnesota Agr. Exp. Sta.)

Germination inhibitor in tubers of yellow nutgrass. Tumbleson, M. E. Usually less than 10% of yellow nutgrass tubers germinate when harvested in the fall, unless the tubers are thoroughly washed in cold water. This treatment increases germination to more than 75%. Water extracts from tubers inhibited germination in tubers of nutgrass and seeds of alfalfa, red clover, peas, soybeans, barley, and oats. To ascertain the chemical nature of this substance, the following procedure was adopted: tubers were comminuted in a Waring Blendor with an equal volume of methanol for 6 minutes, centrifuged at 20,000 x g for 15 minutes, and passed through a Seitz sterilizing filter. The filtrate was concentrated into a syrup *in vacuo* at 40°C, and an equal volume of water added. Absolute ethanol was added to make a 75% ethanol solution, centrifuged for 15 minutes at 20,000 x g, and filtered through a Seitz sterilizing filter. Water was added to obtain a concentration of 1 ml/gm of original tubers (100% solution). The inhibitory substance was heat stable; dialyzable through a dialyzing tubing; not adsorbed by charcoal (Norit A) or an ion-exchange resin (Amberlite MB-1) column; soluble in methanol; elutable from an alumina (Alcoa Grade F-20) column with methanol but not with absolute ethanol; and had an Rf between 0.95 and 1 when chromatographed on Whatman 3MM paper using either butanol:ethanol:water (105:64:31) or butanol:acetic acid:water (25:6:6) as solvent systems. (Contribution of Department of Plant Pathology

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and Botany, Institute of Agriculture, Univ. of Minnesota, St. Paul 1. Paper No. 4502, Scientific Journal Series, Minnesota Agr. Exp. Sta.)

WOODY PLANTS, RIGHTS-OF-WAY, INDUSTRIAL SITES, AND FORESTS

Brush control with various herbicides and their mixtures. Corns, Wm. G. This note supplements the report submitted last year (Page 104) with respect to top-killing and regrowth of the woody species involved. During 1960 observations supported the susceptibility ratings given in the 1959 table. There was slight to moderate regrowth from the base of all species except hazelnut. On July 5, 1960 the entire area of Expt. II (except control) was re-sprayed with 2 lb/A brush-killer (50-50 mixture of butoxy ethanol ester of 2,4-D and iso-octyl ester of 2,4,5-T), giving virtually complete top-kill during 1960 and noticeable improvement in density of grass cover. Quantitative assessment of forage yields and results of additional related tests will be reported later. (Division of Crop Ecology, Dept. of Plant Science, Univ. of Alberta).

Ten years of firelane weed control. Kuntz, J. E., Dosen, R., and Riker, A. J. Weed growth in forest firelanes and access roads constitutes a serious fire hazard and greatly reduces their effectiveness as fire barriers. Weed control annually by mechanical means (with plow, disk, scraper, or rototiller) has critical limitations (high costs, short effect, possible erosion, etc.). Firelanes on the Plainfield sand of central Wisconsin often intersect both natural and planted stands at one-half mile intervals. Weeds include both annuals and perennials. Since 1948, many different herbicides at different concentrations and in various combinations have been tested. Soil sterilants with long residual effects have received special attention. Of these, many gave satisfactory weed control for 1 season; a few, for 2 or 3 seasons. Frequently, deep-rooted perennials persisted and variable regrowth occurred, although weed populations often changed. In 1/10 A plots, monuron at 20 lb/A gave satisfactory weed control for 5 years; at 40 lb/A for at least 8 years. Generally, diuron proved even more effective and uniform than monuron. Commercial applications of diuron at 20 lb/A since 1956 have given excellent and continuing weed control with no retreatment. Little, if any, injury occurred on bordering trees. More recently, simazine and monuron-TCA (Urox) have shown considerable promise. In pulpwood storage yards, in contrast, diuron at 65 lb/A gave satisfactory weed control only for 3 years. (Contributions of the Wisconsin Agr. Exp. Sta. in cooperation with the Wisconsin Conservation Dept., the Nekoosa-Edwards Paper Company, and several chemical companies).

Brush control with Dybar (25% fenuron). Playfair, L. 12 plots, 1/32 of an acre each, treated at 16, 32, 48 and 64 lb/A (of formulation) in June, July, and September 1959, and containing aspen and balsam poplar, burr oak, chokecherry, saskatoon serviceberry, hazelnut, and hawthorn were examined in late summer of 1960. The 48 and 64 lb/A gave good control of all species. 32 lb/A gave spotty control and the 16 lb/A virtually no control. Grass in the 48 and 64 lb/A plots had not recovered from injury. In 1959 it appeared that growth outside of plots might be severely damaged but this was not evident on examination a year after application. Several more plots were treated at same rates during early spring and summer of 1960. One series was put on while snow was still on the ground. An examination of these in early fall of 1960 led to these conclusions: 1. Dybar is not effective at rates much below 50 lb/A. 2. It is not effective in very wet locations, i.e. where surface water remains for most of the season. 3. On heavy soil it may take more than one season to give results. (Contribution of the Manitoba Power Commission.)

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SUMMARY OF NEW RESEARCH FINDINGS

Prepared by the Research Committee

NORTH CENTRAL WEED CONTROL CONFERENCE

(Supplement to Research Summaries, NCWCC, 1958)

FOREWORD

The information presented in this report has been prepared by members of the Research Committee of the North Central Weed Control Conference. It is based on brief research reports submitted for publication in the 1960 Proceedings and on information obtained by correspondence with persons carrying on research in that field.

This is the second supplement to the extensive research summaries prepared by the Research Committee in 1958. It represents findings of the 1960 season, but it is not to be construed as constituting recommendations by the Research Committee or the Conference. The report is intended as a ready source of information on recent weed control investigations for persons engaged in research, extension, regulatory, or industrial work. It is supplemented by the brief reports published in the Proceedings of the 1960 Conference at Milwaukee.

The use of herbicides mentioned in this report is contingent upon registration by the United States Department of Agriculture and/or establishment of residue tolerances where necessary by the United States Department of Health, Education and Welfare. In Canada, similar action is required by the appropriate governmental departments. Herbicides should be used only as recommended on the label. Persons making recommendations for uses beyond those indicated on the label may be held liable.

The rates of application given for the various herbicides are on the basis of acid equivalent, phenol equivalent, or active ingredient, unless otherwise stated.

The Research Committee is organized into 11 projects each having one or two project leaders. The real burden of summarizing the information contained in this report has been on the shoulders of these project leaders. To them and to the many research workers who have contributed brief abstracts of their findings, we wish to express our appreciation and thanks. Without their splendid cooperation, the preparation of this report would not have been possible.

Research Committee,

North Central Weed Control Conference
George Friesen, Chairman
H. A. Friesen, Vice-Chairman

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BASIC STUDIES IN BOTANY, ECOLOGY AND PLANT PHYSIOLOGY

B. J. Rogers

Three of the reports this year concerned a subject which has received much attention in the last few years — herbicide residues in food. This series of studies affords strong evidence that honey bees can produce honey which contains herbicides, and presumably other pesticides or even naturally occurring plant poisons. Radioactivity from labeled 2,4-D and amitrole applied to the foliage of plants was found in the nectar. It was found that bees would pick up nectar from plants treated with various herbicides, but this varied with the plant species and with the herbicide used. Probably this was a function of the amount of disruption in nectar secretion caused by the chemical. At reasonable concentrations the herbicides were not particularly toxic to bees. This information could result in a change in the diets of health food addicts, and certainly poses a problem for the FDA, since honey bees range over a considerable area. It should be noted that actual appearance of herbicides in the honey was not reported.

A good start has been made on the identification of a sprouting inhibitor found in tubers of yellow nutsedge *(Cyperus esculentus)*. This substance also was found to inhibit the germination of several kinds of seeds. Although the literature is well supplied with observational reports on inhibitors, little work has been done on characterization and identification. The possibility that these naturally-occurring inhibitors represent totally new classes of potential herbicides seems to have been overlooked by industry.

Another report adds information to the observation that quackgrass adversely affects the growth of (1) competing crops, and (2) succeeding crops.

Preliminary reports indicated that a toxic substance could be involved. Further experiments suggest that the ability of the quackgrass to compete for minerals in the case of (1), and the high carbon/nitrogen ratio of quackgrass residues turned into the soil by plowing in the case of (2) are more important ecologically than is the toxic material. This is a strong object lesson on the inherent difficulties in coupling laboratory results to field observations.

The prolific nature of yellow nutsedge was illustrated by a somewhat statistical report. For instance, one acre of Minnesota peatland produced 9 tons (fresh wt.) of tubers. If all of these tubers (30 million) produced other tubers at the highest rate given in the report, in the next year it might be expected that 62,100 tons of tubers would be produced on that acre. Although this tremendous production is unlikely, the possibility of high yield of crude plant material from this species is interesting.

Further work on simazine residues in the soil suggest that this herbicide may be a problem under certain cropping systems in the cooler agricultural areas. Applications of 2, 4, and 6 lb/A in 1958 caused a response in oats in 1960 (Minnesota). Granular simazine at 3 lb/A applied in 1959 caused severe injury to tomato transplants a year later, while the wettable powder had no residual effect, (Indiana).

CONTROL OF HERBACEOUS PERENNIAL WEEDS

Lyle A. Derscheid

Johnsongrass *(Sorgum halepense* L.). Data reported in 1960 indicated that several herbicides not mentioned in earlier reports were effective as spot treatments for controlling established stands of Johnsongrass. Over a 3-year period, a 50-50 naptha-diesel oil mixture, ½ gal. of hexachlorocyclopentadiene (C-56) or 2 gal. of HCA in 100 gal. of diesel oil, or 4 lb. of dalapon in 100 gal. of water gave 95% control if applied each time that regrowth reached a height of 6 to 8 inches (3 or 4 treatments per year).

Quackgrass or Couchgrass *(Agropyron repens* L.). Earlier results which indicated that dalapon, simazine, atrazine, amitrole and 2,3,6-TBA were relatively ineffective on this weed, unless augmented by cultivation or mowing, were confirmed. Likewise 2,4-D, 2,4,5-T, and mixtures of the two chemicals continued to be ineffective. Without cultivation two to three applications of amitrole at rates of 15 to 20 lb/A were needed to give complete elimination and two treatments with 40 lb/A of 2,3,6-TBA were needed to reduce stands 95 per cent. Similar treatments with erbon and amitrole T were unsatisfactory. Rototilling improved the effectiveness of amitrole T (amitrole plus ammonium thiocyanate), but treatment with 5, 10 or 20 lb/A followed after 30 days with rototilling failed to kill over 71% of the plants.

Several combinations of cultivation and herbicides were successful in reducing stands of quackgrass 90 to 98 per cent. Some of the better combinations were as follows: (1) spray with 6, 8, 10 or 12 lb/A of dalapon; double one-way disk 3 weeks later; spray with 6, 8, 5 or 6 lb/A of dalapon 6 weeks after one-waying; one-way 2 and 8 weeks after spraying. All treatments reduced the stand over 92%, but those using dalapon at rates of 8 and 8 lb/A or 12 and 6 lb/A had longer residual sterility, maintaining over 90% reduction for over 15 months. (2) Fall plow; spring disk early growth; spray with 12 to 20 lb/A of dalapon or 8 to 12 lb/A of simazine when regrowth was 2 to 3 inches tall; double oneway 2 weeks after spraying. Simazine was much slower acting, but the higher rates of each chemical retained over 90% stand reduction for over 15 months. (3) Spray weeds when 8 inches tall with 8 to 12 lb/A of fenac (2,3,6-trichlorophenylacetic acid); double one-way disk 3 weeks after spraying; one-way disk 1 week after last disking. Results were still improving 15 months after spraying. (4) Spray with atrazine 2 lb/A pre-emergence during May; spray with 2 to 4 lb/A of amitrole, amitrole T, or fenac or 4 to 8 lb/A of dalapon; plow and plant corn. Although all treatments reduced weed stands over 90% the fenac and dalapon injured the corn. (5) Spray with 4 lb/A atrazine and plow.

For small patches of undisturbed sod erbon ⅝ lb/sq rd, monuron ¼ lb/sq rd, simazine ¼ lb/sq rd, CBMM (40% sodium chlorate, 57% sodium metaborate and monuron 1%), 8 lb/sq rd, BMM (94% disodium tetraborate hydrates, 4% monuron), 4 lb/sq rd' atrazine, 5 lb/A, Amizine (15% amitrole and 45% simazine), 10 lb/A, and several mixtures containing atrazine 5 lb/A and other herbicides were very satisfactory. However, borax (61.5% boron trioxide equivalent) 20 lb/sq rd Atlacide (59% sodium chlorate) 8 lb/sq rd, sodium chlorate 6 lb/sq rd, and TCA 140 lb/A were unsatisfactory. Residual sterility of monuron at 10 lb/A lasted 1 year, at 20 lb/A 3 years, at 40 lb/A 7 years and 80 lb/A 7 years.

Canada thistle *(Cirsium arvense* L.) and **perennial sowthistle** *(Sonchus arvensis* L. or *S. uliginosus* Bieb.). Earlier results were confirmed in several experiments in which ½ to 1 lb/A of 2,4-D or MCPA or 1 to 2 lb/A of 4-(MCPB) were ineffective when applied at the bud stage of growth. A 2 lb/A rate of 4-(2,4-DB) controlled top growth but did not reduce stands. Spring tillage followed by treatment with 4 to 8 lb/A of amitrole to both species when 2 to 6 inches tall gave 100% elimination. Other 1960 data indicated that similar treatment with 8 to 12 lb/A of amitrole to the bud stage of growth was less satisfactory on Canada thistle. A 2 lb/A rate of 4-(2,4-DB) ester to both species after spring tillage and before fall tillage reduced stands 100% in one experiment.

Several borate mixtures appeared promising for patch treatment of Canada thistle. The lowest rates used —1⅜ lb/sq rd of XPI 61, which is 45.6% sodium borate plus trichlorophenylacetic acid, 5½ lb/sq rd. of XPI 62, a mixture of sodium borate, monuron and 2,3,6-TBA,

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and 2¾ lb/sq rd of Benzabor, 90% disodium tetraborate hydrates and 8% trichlorobenzoic acid, reduced stands 100%, while XPI 69, a mixture of sodium borate and atrazine, was less effective at 5½ lb/sq. rd.

Leafy spurge (*Euphorbia esula* L.). The repeated use (3 times a year) of 2 to 3 lb/A of several esters and an invert emulsion of 2,4-D continued to give good control of leafy spurge. Rates of 3 to 4 lb/A of erbon, TBA and fenac and 12 lb/A of amitrole were equally effective. In single treatments 15 to 20 lb/A of amitrole T or atrazine gave a high percentage elimination.

Fall application of 2⅜ to 4⅛ lb/sq rd of a BDM (90.5% disodium tetraborate hydrates and 7.5% 2,4-D) or a mixture of borate and 2,2,3-TPA continued to kill over 90% of the leafy spurge plants and similar rates of a BBM (90.5% of disodium tetraborate hydrates and 4% monuron) continued to be ineffective. Residual toxicity of borax (61.5% B_2O_3) at 3 to 15 lb/sq rd, a BDM at 2 to 6½ lb/sq rd and borax (28% B_2O_3) at 6½ to 15 lb/sq rd held leafy spurge in check for 5 years.

Russian knapweed (*Centaurea repens* L.). There were no 1960 data to confirm or deny previous results; however, the residual of 15 lb/A of 2,3,6-TBA or PBA applied in 1958 held Russian knapweed in check for 2 years, but allowed perennial grasses to reinvade the treated area. An 8¾ lb/sq rd application of a CBM (25% sodium chlorate and 73% sodium borates) was holding both in check.

Field bindweed (*Convolvulus arvensis* L.) Single applications of 20 lb/A of 2,3,6-TBA or 40/A of PBA continued to eliminate field bindweed in perennial grass stands without eliminating the grass stands. Two applications of 20 lb/A of PBA applied 6 months apart appeared to have longer residual effect than 1 application of 40 lb/A on bindweed in sub-humid areas on dryland, but not on irrigation. Rates of 1⅜ to 2¾ lb/sq rd of a borate-TBA mixture or 5½ lb/sq rd of a CBM killed top growth, but allowed regrowth.

Hoary cress (*Cardaria draba* (L.) Desv.). Amitrole, amitrole T and 2,3,6-TBA continued to be effective on this species, but higher rates than those previously reported were required. Two treatments one year apart with 8 lb/A of amitrole or 6 lb/A of amitrole T killed tops, but allowed regrowth. Such treatment did not appear to injure crab apple trees. In other experiments single treatments of 9 lb/A of amitrole or 6 lb/A of amitrole T followed by rototilling appeared to be equal to the split applications. Single treatments of 15 lb/A of 2,3,6-TBA or 20 lb/A of Amizine (15% amitrole and 45% simazine) gave excellent control. A borax-monuron-TBA mixture at 5½ lb/sq rd reduced stands 95% while a borax-TBA mixture at 8¼ lb/sq rd was unsatisfactory and 5½ lb/sq rd of borax-atrazine mixture were ineffective.

Woolyleaf franseria (bur ragweed) (*Franseria tomentosa* Gray) Sodium chlorate at 5 and 7 lb/sq rd, PBA at 40 lb/A, 2,3,6-TBA at 40 lb/A, and fenac at 20 lb/A reduced stands 90 per cent. However, lower rates of 10 and 20 lb/A of 2,3,6-TBA, and 5 and 10 lb/A of fenac, reported as being effective in 1959, were not satisfactory. Monuron, fenuron, a BDM, and borax compounds continued to be unsatisfactory.

Toadflax (*Linaria vulgaris* Mill. and *Linaria dalmatica* (L.) Mill). Most of the 1960 work confirms earlier work. Two or three treatments with 5 to 20 lb/A of amitrole gave 100% control. Heavier rates were required in June and July than in August or September. However, in other tests 4 or 5 lb/A applied in May and again in August was equally satisfactory—the same was true for amitrole T, fenac and 2,3,6-TBA. Three treatments with 20 lb/A of 2,4,-D ester, 2,4,-D-2,4,5-T, or erbon failed to reduce stands more than 75 per cent. Single treatments of 17½ lb/A of 2,3,6-TBA, PBA or fenac killed 100% of the toadflax but a similar rate of amitrole T was unsatisfactory.

Application of 3 or 4 lb/A of 2,4-D ester when the weed was budding for 6 years completely eliminated the weed growing in competition with creeping red fescue or bromegrass. Rates of 1 or 2 lb/A reduced the stand but did not eliminate it.

Linaria dalmatica was eliminated with 5½ lb/sq rd of borax and 2 to 5 lb/sq rd of a BDM. Only 50 to 75% kill was obtained with 2 to 16 lb/A of 2,4-D.

Absinthe (*Artemisia absinthium* L.) Two sprayings when weeds were 3 to 4 inches tall with 1 to 1½ lb/A of a 2,4-D ester, a 2,4,5-T ester, 2,4-D-2,4,5-T mixture, amitrole T, 2,3,6-TBA or a MCPA ester gave 100% control. Spraying once each of two years seemed to have some advantage over two sprayings in 1 year. Aproximately three times as much herbicide was needed in one spraying to give comparable results. For patch treatment a BMM at 2¾ lb/sq rd, a BDM at 4 lb/sq rd and several other borax mixtures at 2¾ lb/sq rd reduced the stand almost 100 per cent.

Indian rushpea (*Hoffmanseggia densiflora*). This weed was eliminated with 2,3,6-TBA 20 lb/A, PBA 40 lb/A, fenac 5 lb/A, fenuron ⅜ lb/sq rd and erbon 2 lb/sq rd. Lighter rates of these chemicals were less effective and 6 lb/sq rd of a BDM, 7 lb/sq rd of sodium chlorate and 20 lb/sq rd of borax were also ineffective.

Field horsetail (*Equisetum arvense* L.) As in previous tests, MCPA ester at rates of ¼, ½ and 1 lb/A killed 97, 99 and 100% of the top growth, but ¼ lb/A of 2,4-D ester only killed 79% of top growth. Treatment in mid-July was more effective than in late June. In another experiment ¼ lb/A of MCPA failed to reduce the stand when applied at several dates in June, July and August. Amitrole was ineffective in June but rates of 4 and 8 lb/A killed 90 and 95% of the weed when applied during July and August in Alberta.

CONTROL OF ANNUAL WEEDS

Keith E. Wallace

Grassy annual weeds. Wild oats (*Avena fatua* L.) Twenty-one abstracts reported wild oats control with ¼ to 2 lb/A of barban (trade name—Carbyne) as adequate, excellent, superior, satisfactory, good, poor and by percentages. In most studies ¼ to ½ lb/A gave satisfactory control at the 1½-to 2-leaf stage. Higher rates gave slightly better control at all stages and were more satisfactory at the 2½- 3-leaf stage than lower rates Control was poor at later stages with all rates. One-fourth to ½ lb/A resulted in largest crop yield increases. Rates above ½ lb/A sometimes reduced wheat and barley yields.

One study showed no damage to flax when barban was applied at 1 lb/A or less. One study showed severe damage to rape when barban was applied 15 days after emergence but no damage at ⅓ lb/A or less when applied 10 days post emergence or earlier. One study using barban at ¾ lb/A resulted in less injury to wheat on fertilized than on unfertilized areas.

Barban applied with cone-type nozzles gave better control than fan type in four studies, fan type was better than cone in two studies and no difference in control was observed in four studies.

Thirty-seven abstracts reported experimental and commercial applications of 2,3-dichloroallyl diisopropylthiolcarbamate (trade name -Avadex). Rates of 1 to 2.5 lb/A generally reduced wild oat stands 70 to 95%. Lower percentages of control reported from some studies were attributed to methods and time of incorporation. Ridged soil that was leveled during incorporation resulted in control in alternate strips. Wet soil resulted in poor incorporation and poor control. Methods that gave through incorporation 2 to 4 inches deep were most effective. The same rates applied early post-emergence gave 54, 63 and 82% control. Dimethyl 2,3,5,6-tetra-

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chloroterephthalate at 5, 7.5 and 10 lb/A gave 6, 7 and 13% control when applied early post-emergence. 2,3,6-TBA applied early post-emergence at 2, 4 and 6 lb/A resulted in 41, 39 and 48% control. Treatments with endothal and 2,3,6-TBA when foliage was 4-6 inches tall gave poor control.

Applications of 2,6-dichlorobenzonitrile (Casoron) at rates of 2 to 4 lb/A gave little or no control of wild oats in six studies. In two others 3 and 4 lb/A gave 50 to 62% control when applied at the 1½ to 2¼ leaf stages. In one case flax, barley, and wheat were damaged.

One 5-year study indicated that disking in late September or early October was more effective in keeping the number of wild oats from increasing than tillage in the spring only. In another 1-year study, straw cover had little effect on germination of wild oats.

Foxtails (*Setaria* spp.). One report indicated no control of green foxtail with 2,3-dichloroallyl diisopropylthiolcarbamate and 90 to 100% control for 1 and 2 lb/A rates of 3-amino-2,4-dichlorobenzoic acid (trade name—Amiben). TCA did not give satisfactory control at rates up to 4 lb/A but dalapon gave 90% control with 1 lb/A and stunting at lower rates.

Wild bromegrasses. One report involved control of a mixture of cheat (*Bromus secalinus* L.) hairy chess (*Bromus commutatus* Schrad.), and downy bromegrass (*Bromus tectorum* L.) Pre-emergence applications of CIPC at 3, 4 and 5 lb/A gave 91, 97 and 97% control.

Broadleaved annuals. Wild buckwheat (*Polygonum convolvulus* L.). Barban was reported once as 100 effective on wild buckwheat at 2 leaf stage, but less effective at 4 leaf stage. Two other reports indicated 25 and 50% control in one and "reasonably effective" in the other but gave no stages of development for the buckwheat. Applications up to 1½ lb/A of 4-(2,4-DB) and 4-(MCPB) gave poor and no control respectively of wild buckwheat. Two reports of 2-methoxy-3,6-dichlorobenzoic acid gave 90% control with as low as ¼ lb/A in 6-8 leaf stage, 100% control with as low as 5 oz/A at the 2-leaf stage. An isomeric mixture of MCPA and 2,4,5-T gave 95% control of wild buckwheat with as low as ½ lb/A of active ingredients. Butyl ester of 2,4-D at rates as high as 1 lb/A retarded but did not kill wild buckwheat when applied to plants varying from 2 to 6 leaves in development.

Tartary buckwheat (*Fagopyrum tataricum*(L.) Gaertn.). 2-Methoxy-3,5,6-trichlorobenzoic acid gave 92 to 99% control at from ½ to 2 lb/A. Butoxy ethanol ester of 2,4-D gave 99% control at ¾ lb/A. Thatcher wheat showed tolerance to 2-methoxy-3,5,6-trichlorobenzoic acid.

Purslane (*Portulaca oleracea* L.) Prometone (2-methoxy-4,6-bis(isopropylamino)-*s*-triazine) gave 100% control at 4 lb/A, poor control at 1 and 2 lb/A; atrazine satisfactory. Double disking, double one-way disking or a cultivator followed by a harrow gave satisfactory incorporation. Volumes of carrier had little effect on per cent of control. Generally 10 to 45% reduction of spring wheat stands after emergence resulted from application of 1 to 2.5 lb/A. Three studies showed extreme stand reduction. Where yields were taken most yields were increased even though stands were decreased. Yield increases depended on intensity of wild oats competition. Barley response was similar to spring wheat. Flax, sugar beets, potatoes, peas and sunflowers were not damaged by similar applications.

Prostrate pigweed (*Amaranthus graecizans* L.) Prometone gave satisfactory control at 2 lb/A, 100% control at 4 lb/A; atrazine gave very satisfactory control at 1 lb/A, 100% control at 4 lb/A; 2,4-D gave satisfactory control at 4 lb/A, poor control at 2 lb/A; a mixture of chlorinated benzoic and cresoxyacetic acids gave no control as did 2,3,6-TBA; 4-(2,4-DB) gave satisfactory control at 1 lb/A.

Rough pigweed (*Amaranthus retroflexus* L.) Prometone gave 90% control at 4 lb/A, poor control at 2 lb/A; atrazine gave satisfactory control at 2 lb/A, 100% control at 4 lb/A; 2,4-D gave less than satisfactory control at 4 lb/A, poor control at 2 lb/A; a mixture of chlorinated benzoic and cresoxyacetic acids gave poor control at 4 lb/A; 2,3,6-TBA gave poor control at 4 lb/A; 4-(2,4-DB) gave satisfactory control at 1 lb/A.

Russian thistle (*Salsola Kali* L.) Prometone gave poor control at 4 lb/A; atrazine gave no control at 2 lb/A, 100% control at 4 lb/A; 2,4-D gave poor control at 4 lb/A; a mixture of chlorinated benzoic and cresoxyacetic acids gave poor control at 4 lb/A; 2,3,6-TBA gave poor control at 4 lb/A; 4-(2,4-DB) gave almost complete control at 1 lb/A.

One report indicated *Chenopodium album* L., *Kochia scoparia* L. and *Monolepis nutalliana* (Schultes) at bud or pre-bud stage were almost completely controlled with 1 lb/A of 4-(2,4-DB). Better than satisfactory control of *Brassica kaber* (DC.) Wheeler was given by 1 lb/A of 4-(2,4-DB); *Amaranthus albus, Solanum triflorum* Nutt. and *Helianthus* sp. were satisfactorily controlled with 1 lb/A of 4-(2,4-DB). *Lepidium densiflorum* Schrad. was resistant to 4-(2,4-DB).

WEED CONTROL IN CORN, SORGHUM AND SOYBEANS

R. N. Andersen

Corn. Six reports representing eight studies at seven locations were reviewed. No shortages of moisture following treatment were reported. Five studies were conducted on silty clay loam soil, two on silt loam, and one on a soil described as an alluvial bottomland.

Atrazine, generally at 2 or 3 lb/A, was used in all studies. In seven studies atrazine was used as a pre-emergence treatment, in one as an incorporated pre-planting treatment, and in one as a post-emergence treatment. Atrazine gave good to excellent control of both broad-leaved and grass weeds in all instances except one, in which control was fair to poor.

Simazine and atrazine were compared in pre-emergence treatments in seven of the eight studies. In general, results with simazine and atrazine were similar. In several studies comparisons were made between granular (Attaclay or ammonium sulfate carriers) and wettable powder formulations of simazine and atrazine. In general, little or no differences in effectiveness between granular and wettable powder formulations were noted. In one study, atrazine as the wettable powder was superior to the granular formulation. Granular simazine was not included in that study. In Michigan, atrazine and simazine were applied at 2 lb/A, and wettable powder formulations were compared to granular formulations (Attaclay or ammonium sulphate carriers) with varying concentrations of herbicide. In this study, atrazine in all formulations and simazine as the wettable powder or the 4% granular formulation gave complete control of annual weeds, while granular formulations of simazine which had a concentration greater than 4% did not provide adequate weed control. In Ohio, various types of atrazine and simazine granules were compared to atrazine as the wettable powder. Near perfect control resulted from all treatments.

CDAA plus trichlorobenzyl chloride was used as a pre-emergence treatment in six of the eight studies reviewed and as pre-planting treatment in one. Rates were usually 3 to 4 lb/A CDAA plus 7½ to 10 lb/A trichlorobenzyl chloride. Control of annual weeds was poor at one location, poor to fair at two, fair at one, fair to good at two, and fair to excellent at one location.

Studies at five locations included pre-emergence treatments of 2,4-DEP at rates of 4 to 6 lb/A. Annual weed control ranged from poor to good. Five locations had studies involving pre-emergence treatments with 2,4-D. Several forms of 2,4-D were used and both liquid and granular formulations were tested. Rates were 2 or 3 lb/A. Annual weed control ranged from poor to good.

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Other herbicides too numerous to mention in this summary were included in studies at one or more locations.

Sorghum. Four reports were reviewed. One dealt with varietal differences in tolerance to 2,4-D. Yield reductions from 2 lb/A of butoxy ethanol ester of 2,4-D applied when sorghum was 5 inches tall ranged from no reduction for the most tolerant variety to 37% for the least tolerant.

The remaining three reports dealt with various pre-emergence and post-emergence treatments. Generally good results were obtained from pre-emergence treatments with atrazine, propazine, and CDAA plus trichlorobenzyl chloride. Injury from CDAA and CDAA plus trichlorobenzyl chloride was noted in one of four tests in Minnesota in 1960. Whether or not this caused reductions in yield had not yet been determined. In Nebraska, uncultivated sorghum receiving pre-emergence treatments of CDAA plus trichlorobenzyl chloride, or propazine, or atrazine produced yields comparable to those of a hand weeded check.

Soybeans. Four reports representing studies at six locations were reviewed. Amiben was included as a pre-emergence treatment at all locations. Rates ranged from 2 to 8 lb/A with 2 to 4 lb appearing to be adequate. Results from all locations indicated good to excellent control of annual broad-leaved and grass weeds. No mention was made of any injury to soybeans from amiben. All studies were conducted on silty clay loam or silt loam soil. Granular and liquid formulations of amiben gave similar results in three of the reports. In one, the liquid formulation gave better weed control than did the granular formulation. Rainfall soon after application of amiben was found to be necessary for good weed control. This observation from a study on another crop was mentioned in one report.

Numerous other herbicides, some of which have been tested for a number of years, were included in the reports. Some combinations of herbicides seemed promising but were not widely tested.

WEED CONTROL IN SMALL GRAINS

L. E. Anderson

Major emphasis was again directed to wild oats *(Avena fatua)* control in spring sown wheat, barley, oats and flax. Included among other annual weeds reported on were wild buckwheat *(Polygonum convolvulus)*, Canada thistle*(Cirsium arvense)*, and perennial sowthistle *(Sonchus arvensis)*. No experimental work involving fall sown grains was reported.

Continued interest in 2,3-dichloroallyl diisopropylthiolcarbamate (Avadex) and barban (4-chloro-2-butynyl *N*-(3-chlorophenyl)carbamate) (Carbyne) is evidenced by the great number of experiments reported. 2,6-Dichlorobenzonitrile (Casoron) was also used with varying degrees of success.

Based on information reported in 1960, it appears the optimum rates for Avadex applied for wild oats control in wheat are from 1½ to 2 lb/A. Under favorable conditions these rates reduced the wild oats stand from 70 to 90%. Although the stand of wheat was reduced correspondingly, it was not accompanied by a reduction in grain yield. Barley and flax were reported to be more tolerant to Avadex residues than wheat. As a pre-sowing treatment proper incorporation in the soil is essential to good wild oats control. Avadex incorporated by harrowing alone was less effective than incorporation by double disking or by disking followed by harrowing. It was reported that incorporation should not exceed the 3-inch depth nor should it be incorporated at or near the soil surface. Comparisons of Avadex applied in water at 5 and 10 gal/A did not give consistent results. In some experiments 10 gal/A gave better wild oats control but resulted in greater injury to the crop.

Barban was reported to control wild oats in wheat and barley most successfully when applied at rates of ½ to ¾ lb/A when the wild oats seedlings were in the 1½ to 2 leaf stage of growth. Higher rates of barban were required for control when applied at later stages of growth and were accompanied by a higher degree of crop injury and reduction in yield. The addition of commercial fertilizers to the soil increased the effectiveness of barban and resulted in greater wheat yields. Reinfestations of wild oats were reported where applications were made at a too early date. Barban was not effective when applied prior to wild oats germination. No differences were reported where cone and fan type nozzles were compared.

Control of wild buckwheat was reported with barban at ¼ to ½ lb/A and Casoron at 1¼ lb/A: both herbicides were applied at the 2- to 5-leaf stage of growth and caused wheat injury and yield reductions.

Continued work relative to the effects of dates of tillage to control wild oats substantiated results reported previously.

CONTROL OF WEEDS IN OTHER FIELD CROPS

M. K. McCarty

Forage legumes. Madrid sweetclover given pre-emergence applications of amiben, trietazine and EPTC sustained considerable injury from trietazine and EPTC. Post-emergence applications of trietazine and 4-(2,4-DB) also reduced stands. The amiben caused no injury to sweetclover but weed control was also poor. Soil moisture was good but rainfall was about ½ inch for the two weeks following application. On some adjacent plots, similar rates of amiben gave good weed control where applied two weeks later to soybeans. Nearly 3 inches of rain fell during the two week period following application.

Sugar beets. Pre-planting application of 2,3-dichloroallyl diisopropylthiolcarbamate (Avadex) at 1½ to 2 lb/A on experimental plots and on large acreages by farmers gave good to excellent control of wild oats. Various methods of incorporating the herbicide into the soil were employed. Crop injury was minor. Rates as low as ¾ lb/A were estimated to give 75% control of wild oats. IPC and TCA gave some stand reduction or injury at higher rates reported. Endothal and amine salts of endothal (TD-47 and TD-62) applied pre-emergence gave good to excellent control of smartweed, lambsquarters and ragweed. Post-emergence treatments with TD-47 and TD-62 showed slight beet damage at harvest.

Flax. 2,3-Dichloroallyl diisopropylthiolcarbamate (Avadex) at rates from 1 to 2 lb/A gave varying degrees of control of wild oats depending on method of incorporation into the soil and lapse of time between application and incorporation. Effectiveness was apparently reduced when incorporation could not be done on the same day the material was applied. Effectiveness was also reduced when the incorporation method stirred the soil too deeply. TCA and dalapon at low rates mixed with phenoxyacetics gave good control of foxtail. Yields on treated plots were still somewhat lower than those on weeded checks.

Canning peas. IPC, EPTC, Avadex, trietazine and barban all gave some injury ranging from slight stunting in barban at 1 lb/A to stand thinning with EPTC at 3 lb/A. In a comparison of sodium and amine salts of MCPA at 4, 6 and 8 oz/A with sodium salts and butyl esters of 4-(MCPB) and 4-(2,4-DB) at 16, 20 and 24 oz/A the esters of the butyrics gave better weed control but more damage to the peas. Yield reductions of 15% and 50% for the esters of 4-(MCPB) and 4-(2,4-DB), respectively, were reported. CDAA-T at 11 and 14 lb/A gave good control of both broad-leaved and

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grassy weeds but also some injury to peas. Amiben at 2 and 4 lb/A, diuron at 2 lb/A and trietazine at 4 lb/A also gave satisfactory weed control. Dimethyl 2,3,5,6-tetrachloroterephthalate (Dacthal) at 6 and 12 lb/A, 6-nitro-2,4-dichlorophenol (O.M. 1306) at 5 and 10 lb/A and 2,6-dichlorobenzonitrile (Casoron) at 2 and 4 lb/A did not give satisfactory weed control.

Pasture. Side-oats grama seedlings 2 inches tall were treated with ¼, ½, 1 and 4 lb/A of butoxyethanol ester of 2,4-D. The 4 lb/A rate caused leaf burning and prevented normal root growth. Side-oats grama seedlings treated with ¼, ½ and 1 lb/A of the PGBE ester of 2,4-D when grass was 3 inches tall, 8 inches tall, in the boot stage, and fully headed showed no effects on maturity, forage production or seed production.

Rapeseed. Avadex at 1½ to 2 lb/A gave 95% control of wild oats. Effectiveness was greater where applied in 8.4 gal/A water than in 4.2 gal. Delaying incorporation into soil for 8 days reduced effectiveness 25%. No damage to the rapeseed at any of the rates used. Where Avadex gave good control in 1959, wild oat populations were much reduced in 1960 as compared to adjacent untreated area. Post-emergence treatment with barban (Carbyne) showed severe damage to rape 15 days after emergence but much less damage 10 days after emergence. Casoron gave no damage to rape at 3½ lb/A or less but also no control of wild oats when applied post-emergence.

Tobacco. EPTC and trietazine as pre-planting treatments at 3 lb/A gave fair to good weed control with slight damage. EPTC and trietazine applied post-transplanting gave about the same weed control but slightly more crop damage. Casoron, amiben, and dimethyl 2,3,5,6-tetrachloroterephthalate (Dacthal) gave good weed control but moderate to severe crop damage particularly where Casoron in granular form was incorporated and Dacthal at the higher rates (8 and 12 lb/A).

Other crops. Barban at 1 lb/A gave fair to good suppression of wild oats when applied 17 days after seeding, in a 13 crop trial. No injury to potatoes, cucumbers, carrots, table and sugar beets, and commercial yellow mustard; very slight injury to peas, beans, barley and sunflower; slight to moderate injury to Redwood flax and Golden Seneca corn; and moderate injury to Thatcher wheat were observed. Avadex at 1½ and 2 lb/A and CP7667 (2-chloroallyl dipropyldithiocarbamate) at 2 and 4 lb/A were applied to the same crops as pre-planting treatments. Neither treatment gave any control of broad-leaved weeds but Avadex gave good control of wild oats. The 2 rates of CP7667 gave 70 and 90% control of wild oats respectively. There was little difference in injury rating (listed as none to slight) at the higher rates of the two herbicides on potatoes, cucumbers, carrots, red and sugar beets, mustard, flax, sunflower or corn.

CDAA at 4 lb/A and EPTC, amiben and propazine at 3 lb/A were given pre-emergence evaluation on 12 crop species of potential industrial uses. Only *Sorghum almum* showed tolerance to propazine and only *Rudbeckia bicolor* showed more than slight susceptibility to CDAA. With EPTC and amiben there was a range of tolerance among the species from resistant to susceptible.

CHEMICAL WEED CONTROL IN HORTICULTURAL CROPS

E. K. Alban

Fruit. Atrazine, 5 lb/A; Amizine (mixture of amiben and atrazine), 10/A; and prometone, 12 lb/A were successfully used in controlling annual weeds and quackgrass under established young cherry trees with no apparent injury to the trees.

Vegetables. Amiben, continued to show promise as a pre-emergence treatment on snap bean, lima bean, squash, and carrot. This herbicide was particularly outstanding, used at the rate of 3 to 5 lb/A, on both small-seeded and large-seeded types of lima beans. 2,3,5,6-Tetrachloroterephthalate (Dacthal) and *O*-2,4,dichlorophenyl *O*-methyl isopropylphosphoramidothioate Zytron), were also reported to show promise as pre-emergence herbicides used on carrot, snap bean, lima bean and squash. Two abstracts indicated successful use of *N*-(3,4-dichlorophenyl)methacrylamide, Dicryl and *N*-(3,4-dichlorophenyl)-2-methylpentanamide, (Karsil), in post-emergence treatments on carrots, with weeds about one inch tall.

Turf. No new findings were reported in the abstracts received, although there have been many successful crabgrass control studies carried on during the past season, in the North Central region. At least two herbicides which have been included in these studies were Dacthal and Zytron, mentioned above under the vegetable crop summary.

FORESTRY, ORNAMENTAL NURSERIES, AND SHELTERBELTS WEED CONTROL IN ORNAMENTAL AND FOREST NURSERIES AND PLANTINGS

J. E. Kuntz and L. G. Holm

Chemical herbicides already have provided a valuable silvicultural tool in several different phases of forest management. Herbicides are used to eliminate undesirable "weed" trees from forest stands; to maintain firelanes, access roads, utility lines, drainage ditches, mill yards, and pulpwood storage areas; to weed ornamental and forest tree nurseries; to reduce weed competition to new forest plantings, Christmas tree plantings, windbreaks, shelterbelts, and game food plantings; to control forest tree diseases; and to debark trees. So far, major attention has been given the testing of new materials for specific purposes in the field as well as the development of improved methods of application. Much more fundamental information is needed regarding effective chemicals, their mode of action upon plants and soil microorganisms, and their movement and persistence in different soils under different conditions.

Although few research reports have appeared in 1959 and 1960, problems of weed control in tree nurseries and especially in field plantings have received increasing attention—both by researchers and by commercial growers. Several new herbicides have shown promise. Recent trends are summarized.

Field plantings. New tree plantings have been treated generally at the time of planting. Herbicides such as simazine, atrazine, other triazines, dalapon, monuron, diuron, and amitrole, alone and in combination, usually were applied in bands to scalped rows just ahead of the planting shoe. Results have varied with dosage, rainfall, soil type, and weed species. Often combinations of an herbicide giving quick-kill with one giving lasting effects have been most effective.

Older plantings, overgrown and suppressed by weeds and especially grass, have challenged new materials and methods of application. Precautions must be observed with overall foliage sprays, because of the danger of contact injury. Treatment with some of the triazines, with mixtures of triazines and amitrole, and with mixtures of the triazines and dalapon have shown promise. SMDC and DMTT have been used to eradicate established stands of quack grass around three-to-four-year-old apple trees. These materials were applied as drenches in limited quantities so as to kill weeds but spare the trees.

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Nurseries. Attention to weed control in seedling and transplant beds has continued. Easier and more effective techniques of application have renewed interest in soil fumigants. More lasting weed control has been sought with new herbicides. The triazines, at low dosages, have shown promise in certain situations. Pre-emergence treatments with simazine and atrazine caused no reduction in pine seed germination but incited severe injury to young seedlings. Post-emergence, overall treatments caused variable injury to young seedlings, less injury to seedlings two months old, and little or none to transplants. Seedlings of both conifers and deciduous species reacted differently to triazines. Such variations demand careful attention. Simazine persisted in treated layers of nursery soil even after heavy leaching. EPTC in liquid and granular form also has given good weed control with little, if any, adverse effects on the majority of tree species tested.

In nurseries, where herbicides and other biocides are applied year after year to light sandy soils supporting the same or different tree species of varying ages, special attention must be given to the uptake, movement, and persistence of these materials. Likewise, immediate or prolonged effects on beneficial soil microorganisms must be evaluated.

Disease control. The control of certain forest tree diseases constitutes a somewhat unique, though an important, use of herbicides. Infectious tree diseases, as well as those of most other plants, are controlled mainly by measures designed to prevent either the spread of the inciting agents or the initial infection of the host. For example, several rust diseases kill forest trees or limit their growth and productivity. By eradicating nearby alternate hosts which are necessary for the completion of the life cycle of the respective fungus pathogens, the more valuable trees are protected from infection. Effective disease control programs based on this principle include the protection of 5-needled pines from white pine blister rust by *Ribes* eradication and the protection of cultivated and ornamental apples from cedar apple rust by elimination of red cedars. In all these problems, the use of herbicides has replaced laborious and costly hand eradication methods.

Herbicides also have played an important role in preventing or reducing the spread of oak wilt. Silvicides have been used to treat infected oak trees to hasten their death, decortication, and desiccation. Fungus mats, which serve as sources of inoculum for long distance spread of the fungus, seldom form on such treated trees. The oak wilt fungus also spreads from tree to tree in local areas through underground root grafts. In woodland areas, where individual trees are of relatively low value, poisoning healthy oaks bordering a wilt-infected pocket has prevented further spread. Sodium arsenite, injected into the root collar or buttress roots of trunk-girdled trees, has proved especially effective. Less toxic chemicals, such as Ammate, 2,4-D or 2,4,5-T also have been used. More recently, killing portions of connected roots with soil fumigants has provided another means of control, especially for trees in lawns and parkways. Neither dyes, poisons, nor the oak wilt fungus passed through sections of roots killed by injections of methyl bromide or SMDC in sandy soil between healthy and inoculated oak trees.

WOODY PLANT CONTROL

R. H. Beatty

Long-range studies of the effect of various herbicides and their mixtures on brush and forage yields are continuing. On sand dunes in Alberta, virtually complete top kill of mixed species, as well as improved grass cover, resulted from retreatment with 2 lb/A brush-killer (2,4-D plus 2,4,5-T) a year after the first application.

Fenuron at 12 and 16 lb/A in 25% pellets (Dybar) (48 to 64 lb/A of product) gave good control of aspen, balsam poplar, burr oak, chokecherry, saskatoon, hazelnut and hawthorne a year after application in Manitoba, but was not effective at lower rates, or in very wet loactions. Reaction was slow on heavy soil.

Monuron at 20 lb/A gave satisfactory control of weeds on Wisconsin firelanes for 5 years; at 40 lb/A, for at least 8 years. Generally diuron was more effective and uniform, with little or no injury to bordering trees, but was less satisfactory in pulpwood storage yards. Simazine and monuron-TCA appear promising.

AQUATIC WEEDS

J. E. Gallagher

At the Sand Lake National Wildlife Refuge of South Dakota Amitrole-T (Amitrole + ammonium thiocyanate) at 2 gal/A as an aerial application has given 85% kill of phragmites and cattail.

Endothal at 1 ppm has given good kill of *Potamogeton pectinatus* and *Potamogeton crispus*. *Ceratophyllum demersum* (coontail) was controlled at rates of 5 ppm.

Simazine at 6 ppm was effective on *Jussiaea diffusa* (water primrose).

2,4-D and 2,4,5-TP were effective against the submerged species *Myriophyllum* and *Ceratophyllum demersum* at rates of 4 and 2 ppm, respectively.

NEW HERBICIDES

A. J. Watson

This report summarizes results reported in 1960 for the more recently introduced herbicides. Only those materials are considered "New" which were reported for the first time in the 1959 or 1960 NCWCC abstracts. Where known, the common name, trademark or code number is indicated in parenthesis following the chemical nomenclature.

2-dimethylamino-1,4-naphthoquinone (9S4) (2 reports).

Used pre-emergence at 4 lb/A on carrots and onions in muck soil. Control of annual weeds and grasses was poor. There was no apparent crop injury.

***N*-(3,4-dichlorophenyl)methacrylamide (Dicryl)** (4 reports).

Dicryl has shown considerable promise for either pre- or post-emergence selective use in carrots. Control of annual broadleaved weeds ranged from poor to excellent. There was no apparent injury to carrots.

Onions were injured severely by a 4 lb/A post-emergence treatment.

***N*-(3,4-dichlorophenyl-2-methylpentanamide (Karsil)** (4 reports).

Good control of annual weeds in carrots was reported using 3 to 6 lb/A either pre- or post-emergence without apparent crop injury.

Onions were injured severely by 2 lb/A applied post-emergence.

***N*-(3-chloro-4-methylphenyl)-2-methylpentanamide (Solan)** (2 reports).

Promising results were reported for both pre- and post-emergence use on carrots at 4 to 6 lb/A.

Dimethyl 2,3,5,6-tetrachloroterephthalate (Dachtal) 7 reports).

Used pre-emergence at rates up to 10 lb/A weed control was erratic with generally poor control of broadleaved annuals. The compound appeared selective on carrots at 4 to 6 lb/A but not on red beets, cabbage, snap beans, cucumbers, peas or squash. As an overall post-

tobacco was severely injured. Weed control was variable.

***O*-(2,4-dichlorophenyl) *O*-methyl isopropylphosphoramidothioate (Zytron)** (6 reports).

Soybeans, onions, carrots, cabbage, snap beans, squash and peas were reported more or less tolerant to pre-emergence applications of Zytron. While weed control was erratic, in general, control of annual grasses was good but poor control of several species of broadleaved weeds resulted from pre-emergence applications of 10 to 20 lb/A. Red beets and cucumbers were severely injured. Carrots were not injured by post-emergence applications up to 10 lb/A but weed control was poor.

Methyldichlorobenzoic acid (HN-1688) (2 reports).

Pre-emergence on corn at 2 or 4 lb/A this compound resulted in good control of broadleaved annuals, fair control of grasses and at the higher rate, caused temporary early season injury. It was effective post-emergence on wild buckwheat but injured Selkirk wheat.

Nitrotrichlorobenzoic acid (HN-1763) (1 report).

Used pre-emergence at 4 to 8 lb/A on corn it gave fair to good weed control. The higher rate caused temporary early season injury.

2-Methoxy-3,6-dichlorobenzoic acid (Velsicol B) (1 report).

This compound was applied pre-emergence to red beets, carrots, cabbage and onions on muck soil with a variable dosage sprayer. There was no selectivity indicated for these crops.

***n*-Propyl di-*n*-propylthiolcarbamate (R-1607)** (1 report).

Used pre-emergence on corn at 2 to 6 lb/A it gave emergence treatment carrots tolerated to 10 lb/A while good control of annual weeds but caused some epinasty to the crop.

Propyl ethyl-*n*-butylthiolcarbamate (R-2061) (3 reports).

This compound used post-emergence at 5 lb/A resulted in poor control of broadleaved weeds, no injury to carrots but caused moderate injury to onions. Pre-emergence applications to soybeans at 2 to 6 lb/A gave poor weed control and no crop injury.

2,6-Dichlorobenzonitrile (Casoron) (5 reports).

As a pre-emergence herbicide at 2 or 4 lb/A Casoron gave erratic results. Weed control varied from poor to good with no injury to peas but severe injury to soybeans, grain sorghum, corn and tobacco.

Ethyl-*o*-nitrophenyl sulfide (CP-13842) (1 report).

Used pre-emergence on soybeans at 4 to 12 lb/A it gave good control of annual grasses, poor control of broadleaved weeds and no crop injury.

6-Nitro-2,4-dichlorophenol (O.M. 1306) (2 reports).

At rates of 5 to 10 lb/A pre-emergence weed control was poor and there was no evidence of selectivity on snap beans, peas, squash or cucumbers.

***Sec.*-butynol *m*-chlorocarbanilate (CP-18799)** (1 report).

At rates of 4 to 8 lb/A pre-emergence on soybeans control of annual grasses was very good, broadleaved weed control poor and no injury to the crop.

***d*-4-Chloro-2-methylphenoxypropionic acid (Compitox)** (1 report).

Used post-emergence on established turf this compound controlled several species of chickweed but caused temporary injury to fescue and bluegrass.

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Weeds, Crops, and General Index

The common and scientific names in this list have been made to conform to the list in the Report of the Terminology Committee of the Weed Society of America (Weeds 8:487-521), but the text has not been so edited in all cases.

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Hazelnut	*Corylus cornuta*	107
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Mustard, wild	*Brassica kaber*	78, 89, 102
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P		
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Pastures, weed control in		115
Peanuts	*Arachis hypogaea*	46, 56, 57
Peas	*Pisum sativum*	42, 43, 44, 56, 97, 100, 114
Peppers	*Piper* sp.	56, 57
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Pesticides, obligations of sellers and users		33
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Pigweed, prostrate	*Amaranthus graecizans*	78, 113
Pigweed, rough or redroot	*Amaranthus retroflexus*	78, 86, 87, 88, 97, 99, 100, 102, 113
Pigweed, smooth	*Amaranthus hybridus*	26
Pigweed, tumble	*Amaranthus albus*	78
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Pine, Jack	*Pinus banksiana*	14
Pine, red	*Pinus resinosa*	12, 14, 104, 105
Pine, shortleaf	*Pinus echninata*	15
Pine, white	*Pinus strobus*	12, 104
Plastic cover, as weed control		54, 103
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Privet	*Ligustrum* sp.	51
Pumpkin	*Cucurbita* sp.	46
Purslane	*Portulaca oleracea*	51, 78, 87, 102, 103, 113
Pyracantha	*Pyracantha* sp.	50
Q		
Quackgrass	*Agropyron repens*	25, 81, 82, 83, 84, 87, 103, 106, 111
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Radish	*Raphanus sativus*	56
Ragweed, common	*Ambrosia artemisiifolia*	56, 86, 87, 89, 102
Ragweed, giant	*Ambrosia trifida*	13
Ragweed, bur, see Franseria		
Rapeseed	*Brassica* sp.	44, 75, 76, 92, 99, 115
Reedgrass, marsh	*Calamagrostis canadensis*	104
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Weeds, Crops, and General Index (Continued)

Common name	Scientific name	
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Rose, multiflora	*Rosa multiflora*	51
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Rushpea, Indian, see hogpotato		
Rye	*Secale cereale*	71
Ryegrass, perennial	*Lolium perenne*	22
S		
Sedges	*Carex* sp.	27
Seeds, entry of herbicides		39
Serviceberry, Saskatoon	*Amelanchier alnifolia*	107
Sida, prickly	*Sida spinosa*	100
Sheperdspurse	*Capsella bursa-pastoris*	102
Small grains, weed control		114
Smartweeds	*Polygonum* sp.	42, 99, 102
Smartweed, ladysthumb	*Polygonum persicaria*	42, 97, 99, 103
Smartweed, Pennsylvania	*Polygonum pennsylvanicum*	86, 89
Sorghum	*Sorgum vulgare*	26, 46, 56, 87, 88, 114
Sorghum, wild	*Sorgum* sp.	86
Sowthistle, perennial	*Sonchus arvensis*	78, 111
Soybeans	*Glycine max*	26, 45, 46, 56, 88, 89, 90, 114
Spinach	*Spinacia* sp.	56
Spruce	*Picea* sp.	105
Spurge, leafy	*Euphorbia esula*	81, 112
Spurry, corn	*Spergula arvensis*	102
Squash	*Cucurbita* sp.	46, 56
Stinkgrass	*Eragrostis cilianensis*	55
Strawberry	*Fragaria* sp.	52, 55, 57
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Sunflower	*Helianthus* sp.	44, 56, 78, 99, 100
Sweetclover	*Melilotus* sp.	46, 99, 106
Sweetpotato	*Ipomea batatas*	57
Swimming pools, algae control		30

Common name	Scientific name	
T		
Thistle, Canada	*Cirsium arvense*	78, 79, 85, 111
Thistle, Russian	*Salsola kali*	78, 79, 113
Tillage (for weed control)		46, 54, 74, 82, 83
Toadflax, yellow	*Linaria vulgaris*	83, 84, 112
Toadflax, Dalmatian	*Linaria dalmatica*	84
Tobacco	*Nicotiana tabacum*	57, 100, 115
Tomato	*Lycopersicum esculentum*	46, 53, 54, 55, 56, 57
Toxic compounds in weeds		106
Toxicity, residual, from herbicides		18, 40, 50, 90
Toxicity, arsenic		25, 30
Trefoil, birdsfoot	*Lotus corniculatus*	56
Turf, weed control		22, 23, 24, 25, 103, 104, 115
Turnip	*Brassica rapa*	56, 57
V		
Velvetleaf	*Abutilon theophrasti*	13, 86, 87
Vervain, blue	*Verbena hastata*	13
W		
Watermelon	*Citrullus vulgaris*	56, 57
Weed infestations, evaluation		17
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Wheat	*Triticum vulgare*	20, 42, 43, 44, 56, 71 to 77, 90 to 95, 100
Wheatgrass, crested	*Agropyron cristatum*	104
Wildlife areas, herbicides in management		27
Wildlife, shrubs planted for, weed control		16
Willow	*Salix* sp.	28
Woodsorrel	*Oxalis* sp.	100
Woody plant control		116
Wormwood, absinth	*Artemesia absinthium*	78, 79, 84, 112
Y		
Yew	*Taxus* sp.	50, 51

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Herbicide List and Index

The nomenclature of this list is based so far as possible on the Report of the Terminology Committee of the Weed Society of America (Weeds 8: 487-521). Herbicides are indexed under the common name given in that list if there is one, otherwise under the chemical name; trademarks and code numbers are given for identification. The "Summary of New Research Findings" has not been indexed for herbicides.

Names which begin with numerals are indexed as if spelled out; capitalization is indicated.

A

AMA—code for ammonium methyl arsonate
AMA-41—code for calcium propyl arsonate
amiben—3-amino-2,5-dichlorobenzoic acid 45, 53, 54, 78, 88, 89, 97, 99, 100, 101, 102, 103
Amino triazole—amitrole
amitrole—3-amino-1,2,4-triazole 15, 19, 59, 60, 79, 80, 81, 84, 86, 104, 105
amitrole-simazine mixture 101, 103, 104
amitrole-T—3-amino-1,2,4-triazole plus ammonium thiocyanate 80, 81, 83, 84, 86, 103
Amizine—trademark for mixture of amitrole 15%, simazine 45%
Ammate X—trademark, formulation of AMS
ammonium methyl arsonate (AMA) 25
ammonium sulfamate—AMS
AMS—ammonium sulfamate 15, 59
arsenic—see sodium arsenite, DMA
Atlacide—trademark for a mixture containing 58% sodium chlorate
atrazine—2-chloro-4-ethylamino-6-isopropylamino-*s*-triazine 12, 15, 19, 25, 26, 48, 49, 59, 78, 81, 83, 84, 85, 86, 87 88, 101, 103, 104, 105
Avadex—trademark for 2,3-dichloroallyl diisopropylthiolcarbamate

B

barban—4-chloro-2-butynyl *N*-(3-chlorophenyl)carbamate 20, 21, 42, 55, 70, 71, 72, 73, 74, 75, 76, 77, 90, 91, 95, 98
Baron—trademark for erbon
BDM—borate-2,4-D mixture 81, 84, 85
Benzabor—trademark for borate-2,3,6-TBA mixture
B-562—code for 2-*N*-isopropylamino-1,4-naphthoquinone
B-521—code for 2-*N*-propylamino-1,4-naphthoquinone
BMM—borate-monuron mixture 81, 82
Borascu—trademark for sodium borate ore, 34% boron trioxide
Borascu, Concentrated—trademark for anhydrous sodium borate ore, 61.5% boron trioxide
borate-atrazine mixture (XPI 69) 84
borate-fenac mixture (XPI-61) 80, 81, 84, 85
borate-monuron-fenac mixture (XPI 63) 84
borate-monuron-2,3,6-TBA mixture (XPI 62) 84, 85
borate-simazine mixture (XPI 29) 84
borate-2,3,6-TBA mixture (Benzabor) 80, 85
borax—crystallized sodium borate, $Na_2B_4O_7 10H_2O$ 15, 84

C

calcium arsenate 22, 25
calcium propyl arsonate (XF 832) (AMA 41) 22, 25
Carbyne—trademark for barban
Casoron—trademark for 2,6-dichlorobenzonitrile
CBM—chlorate-borate mixture 15, 59, 80, 82, 84
CBMM—chlorate-borate-monuron mixture 59, 82
CDAA—2-chloro-*N*,*N*-diallylacetamide 12, 15, 45, 48, 49, 53, 54, 55, 56, 86, 87, 88, 89, 97, 99, 100, 101, 102, 103, 105
CDEC—2-chloroallyl diethyldithiocarbamate 12, 45, 53, 54, 101, 105
Celatox—mixture of MCPA and 2,4,5-T
C-56—code for hexachlorocyclopentadiene
chlorate—see sodium chlorate
Chlorax—trademark for a CBM
chlordane—1,2,4,5,6,7,8,8-octachloro-4,7-methano-3a,4,7,7a-tetradhydroindane 22
Chlorea—trademark for a CBMM
CIPC—isopropyl *N*-(3-chlorophenyl)carbamate 13, 15, 45, 53, 55, 56, 59, 78, 89, 101, 102, 103
Compitox—*d*-4-chloro-2-methylphenoxypropionic acid
CP-1815—code for a mixture of chlorinated benzoic and cresoxyacetic acids 78, 81, 84
CP-5996—code for 2,6-dichlorobenzonitrile
CP-7667—code for 2-chloroallyl dipropyldithiocarbamate
CP-13842—code for ethyl *o*-nitrophenyl sulfide
CP-18799—code for *sec*-butynol *m*-chlorocarbanilate

Herbicide List and Index (Continued)

D

dalapon—2,2-dichloropropionic acid 13, 14, 16, 19, 27, 38, 52, 59, 60, 78, 82, 83, 85, 95, 98, 99, 104, 105
DAC893—code for dimethyl 2,3,5,6-tetrachloroterephthalate
Dacthal—trademark for dimethyl 2,3,5,6-tetrachloroterephthalate
DB Granular—trademark for a BDM
d-4-chloro-2-methylphenoxypropionic acid (Compitox) 103
Dicryl—trademark for *N*-(3,4-dichlorophenyl)methacrylamide
dimethyl 2,3,5,6-tetrachloroterephthalate (DAC 893) (Dacthal) 22, 24, 51, 52, 53, 54, 55, 78, 97, 100, 101, 102
Diphenamid—trademark for *N*,*N*-dimethyl-2,2-diphenylacetamide
diphenylacetonitrile (L-13489) (Diphenatrile) 23, 52
diuron—3-(3,4-dichlorophenyl)-1,1-dimethylurea 14, 56, 59, 86, 97, 102, 103, 104, 107
DMA—disodium monomethylarsonate 25
DMTT—3,5-dimethyltetrahydro-1,3,5,2*H*-thiadiazine-2-thione (Mylone) 103
DNBP—4,6-dinitro-*o*-*sec*-butylphenol 53, 56, 86, 89, 102, 105, 106
Dybar—trademark for pelleted 25% fenuron

E

endothal—3,6-endoxohexahydrophthalic acid 15, 29, 47, 55, 59, 78, 98
endothal, coco amine salt (Pennsalt TD-47) 55, 98
endothal, tallow amine salt (Pennsalt TD-62) 55, 98
Eptam—trademark for EPTC
EPTC—ethyl-*N*,*N*-di-*n*-propylthiolcarbamate 12, 45, 52, 53, 54, 55, 74, 86, 87, 89, 97, 98, 99, 100, 105
erbon—2-(2,4,5-trichlorophenoxy)ethyl 2,2-dichloropropionate 27, 59, 81, 82, 84, 85
ethyl ethyl-*n*-butylthiolcarbamate (R-2060) 55
ethyl *o*-nitrophenyl sulphide (CP-13842) 89
EXD—ethyl xanthogen disulfide 55, 103

F

Falone—trademark for 2,4-DEP
fenac—2,3,6-trichlorophenylacetic acid 18, 81, 83, 84, 85, 86, 104
fenuron—3-phenyl-1,1-dimethylurea 14, 15, 19, 59, 85, 107
fenuron.TCA—3-phenyl-1,1-dimethylurea trichloroacetate (Urab) 58
4-chloro-2-butynyl *N*-allyl-*N*-(3-chlorophenyl)carbamate (S-3825) 71
4-(MCPB)—4-(2-methyl-4-chlorophenoxy)butyric acid 77, 79, 97, 106
4-thiocyanato-2-butynyl *N*-(3-chlorophenyl)carbamate (S-3776) 71
4-(2,4-DB)—4-(2,4-dichlorophenoxy)butyric acid 77, 78, 79, 97, 105, 106

G

G-30026—2-chloro-4-isopropylamino-6-methylamino-*s*-triazine
G-34161 (Prometryne)—2,4-bis(isopropylamino)-6-mercapto-*s*-triazine
G-34162 (Atrametryne)—2-ethylamino-4-isopropylamino-6-methylmercapto-*s*-triazine
GC-6691—3-(3,4-dichlorophenyl)-1,1-dimethylurea dodecylbenzene sulfonate

H

HCA—hexachloroacetone 85
Herbisan 5—trademark for EXD
hexachloropentadiene (C-56) 85
HN 1688—methyldichlorobenzoic acid
HN 1793—nitrotrichlorobenzoic acid

I

ipazine—2-chloro-4-diethylamino-6-isopropylamino-*s*-triazine 26, 53, 101
IPC—isopropyl-*N*-phenylcarbamate 89, 97, 98

K

Karsil—trademark for *N*-(3,4-dichlorophenyl)-2-methylpentanamide

L

L-13489—code for diphenylacetonitrile
L-31864—code for *N*,*N*-di(*n*-propyl)-2,6-dinitroaniline
L-34134—code for *N*,*N*-dimethyl-2,2-diphenylacetamide

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Herbicide List and Index (Continued)

M

MCP—MCPA
MCPA—2-methyl-4-chlorophenoxyacetic acid 42, 77, 79, 80, 95, 97, 105, 106
MCPA-2,4,5-T mixture (Celatox) 77
MCPB—4-(MCPB)
methoxy propazine—obsolete name for prometone
methyl bromide 17, 104
methyldichlorobenzoic acid (HN 1688) 86
MH—maleic hydrazide 60
monuron—3-(*p*-chlorophenyl)-1,1-dimethylurea 14, 19, 59, 82, 85, 101, 102, 103, 104, 107
monuron.TCA—3-(*p*-chlorophenyl)-1,1-dimethylurea trichloracetate (Urox) 15, 58, 82, 107
Mylone—trademark for DMTT

N

neburon—1-*n*-butyl-3-(3,4-dichlorophenyl)-1-methylurea 12, 15, 16, 47, 53, 54, 55
N-4512—code for *N*-(3-chloro-4-methylphenyl)-2-methylpentanamide
N-4556—code for *N*-(3,4-dichlorophenyl)methacrylamide
N-4562—code for *N*-(3,4-dichlorophenyl)-2-methylpentanamide
N-5996—code for 2,6-dichlorobenzonitrile
9S4—code for 2-dimethylamino-1,4-naphthoquinone
nitrotrichlorobenzoic acid (HN 1793) 86
N,N-dimethyl-2,2-diphenylacetamide (Diphenamid) (L-34134) 23, 52, 55
N,N-di(*n*-propyl)-2,6-dinitroaniline (L-31864) 23, 52
Novon—trademark for erbon
NPA—*N*-1-naphthylphthalamic acid 12, 89, 105
n-propyl-di-*n*-propylthiolcarbamate (R-1607) 86
N-(3-chloro-4-methylphenyl)-2-methylpentanamide (Solan) (N-4512) 53, 54, 55, 102
N-(3,4-dichlorophenyl)methacrylamide (Dicryl) (N-4556) 53, 55, 101, 102
N-(3,4-dichlorophenyl)-2-methylpentanamide (Karsil) (N-4562) 53, 55, 101, 102

O

O.M. 1306—code for 6-nitro-2,4-dichlorophenol
O-2,4-dichlorophenyl *O*-methyl isopropylphosphoramidothioate (Zytron) 22, 52, 53, 54, 89, 101, 102

P

PBA—mixtures of chlorinated benzoic acids ranging from dichloro- to pentachloro- 26, 59, 80, 84, 85
PCP—pentachlorophenol 15, 46, 59, 60, 89
Polybor-chlorate—trademark for a CBM
polychlorobenzoic acids—PBA
prometone—2-methoxy-4,6-bis(isopropylamino)-*s*-triazine 78, 81, 84, 103
propazine—2-chloro-4,6-bis(isopropylamino)-*s*-triazine 12, 26, 53, 87, 88, 99, 105
propyl di-*n*-propylthiolcarbamate (R-1607) 86
propyl ethyl-*n*-butylthiolcarbamate (Stauffer R-2061) 55, 89, 101

R

Randox—trademark for CDAA
Randox T—trademark for CDAA plus trichlorobenzyl chloride
R-1607—code for propyl-di-*n*-propylthiolcarbamate
R-2060—code for ethyl ethyl-*n*-butylthiolcarbamate
R-2061—code for propyl ethyl-*n*-butylthiolcarbamate

S

sec-butynol *m*-chlorocarbanilate (CP-18799) 89
sesone—sodium 2,4-dichlorophenoxyethyl sulphate 12, 15, 16, 52, 105
silvex—2-(2,4,5-trichlorophenoxy)propionic acid 13, 15, 22, 23, 60, 104
simazine—2-chloro-4,6-bis(ethylamino)-*s*-triazine 12, 13, 15, 16, 26, 40, 49, 50, 52, 53, 54, 55, 56, 59, 82, 85, 86, 87, 88, 90, 101, 103, 104, 105, 107
simetone—2-methoxy-4,6-bis(ethylamino)-*s*-triazine 12, 26, 105
6-nitro-2,4-dichlorophenol (OM-1306) 97, 102
SMDC—sodium *N*-methyldithiocarbamate (Vapam) 17, 103, 104
sodium arsenite 25, 30, 60, 103, 104
sodium borate 59, 81, 82, 85
sodium chlorate 15, 59, 60, 82, 85
sodium chloride 59
Solan—trademark for *N*-(3-chloro-4-methylphenyl)-2-methylpentanamide
S-3825—4-chloro-2-butynyl *N*-allyl-*N*-(3-chlorophenyl)carbamate
S-3776—4-thiocyanato-2-butynyl *N*-(3-chlorophenyl)carbamate
Stoddard Solvent—petroleum product containing 15 to 18 percent of aromatic compounds 101, 102

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Herbicide List and Index (Continued)

T

TBA—2,3,6-TBA
TCA—trichloroacetic acid 15, 19, 59, 60, 78, 82, 95, 98, 104, 105
3-amino-2,5-dichlorobenzoic acid—amiben
3-(3,4-dichlorophenyl)-1,1-dimethylurea—diuron
3-(3,4-dichlorophenyl)-1,1-dimethylurea dodecyl benzene sulfonate (GC-6691) 101, 103
trichlorobenzyl chloride trichlorobenzoic acid, see 2,3,6-TBA (plus CDAA—Randox T) 45, 48, 49, 55, 86, 87, 97 100, 101, 102, 103
trietazine—2-chloro-4-ethylamino-6-diethylamino-*s*-triazine 26, 52, 53, 97, 99, 100, 101, 102
tris(2,4-dichlorophenoxyethyl) phosphite—2,4-DEP
2-chloroallyl dipropyldithiocarbamate (CP 7667) 100
2-chloro-4-diethylamino-6-isopropylamino-*s*-triazine—ipazine
2-chloro-4-ethylamino-6-diethylamino-*s*-triazine—trietazine
2-chloro-4-ethylamino-6-isopropylamino-s-triazine—atrazine
2-chloro-4-isopropylamino-6-methylamino-*s*-triazine (G-30026) 12, 15, 26, 88, 105
2-chloro-4,6-bis(ethylamino)-*s*-triazine—simazine
2-chloro-4,6-bis(isopropylamino)-*s*-triazine—propazine
2-dimethylamino-1,4-naphthoquinone (9S4) 55, 101
2-ethylamino-4-isopropylamino-6-methylmercapto-*s*-triazine (Atrametryne) (G-34162) 78
2,4-bis(isopropylamino)-6-mercapto-*s*-triazine (Prometryne) (G-34161) 88, 89
2,4-D—2,4-dichlorophenoxyacetic acid ..... 13, 14, 19, 22, 26, 27, 28, 29, 38, 42, 45, 49, 52, 59, 60, 77 to 81, 83, 84, 86, 87, 88, 90 to 95, 101, 104, 105, 106, 107
2,4-DB—4-(2,4-DB)
2,4-DEP—tris(2,4-dichlorophenoxyethyl) phosphite (Falone) 26, 52, 86
2,4-DES—obsolete abbreviation for sesone
2,4-D-2,4,5-T mixtures 81, 84, 107
2,4,5-T—2,4,5-trichlorophenoxyacetic acid 15, 27, 38, 60, 78, 84, 104, 105, 106
2,4,5-TES—sodium 2,4,5-trichlorophenoxyethyl sulfate 15
2,4,5-TP—2-(2,4,5-TP) (silvex)
2-methoxy-4,6-bis(ethylamino)-*s*-triazine—simetone
2-methoxy-4,6-bis(isopropylamino)-*s*-triazine—prometone
2-methoxy-3,5,6-trichlorobenzoic acid (Velsicol C) 77
2-methoxy-3,6-dichlorobenzoic acid (Velsicol B) 77
2-*N*-isopropylamino-1,4-naphthoquinone (Naugatuck B-562) 53
2-*N*-propylamino-1,4-naphthoquinone (Naugatuck B-621) 53
2,6-dichlorobenzonitrile (CP or Niagara 5996) (Casoron) 53, 55, 56, 57, 71, 76, 86, 88, 89, 90, 91, 95, 97, 100
2,3-dichloroallyl diisopropylthiolcarbamate (Avadex) ..... 20, 21, 43, 44, 70, 71, 72, 73, 74, 75, 78, 87, 90 to 100
2,3,6-trichlorophenylacetic acid—fenac
2,3,6-TBA—2,3,6-trichlorobenzoic acid (See also PBA) 26, 78, 79, 80, 81, 84, 85, 86
2-(2,4,5-TP)—silvex

U

Urab—trademark for fenuron.TCA
Ureabor—trademark for a BMM
Urox—trademark for monuron.TCA

V

Vapam—trademark for SMDC
Velsicol B—trademark for 2-methoxy-3,6-dichlorobenzoic acid
Velsicol C—trademark for 2-methoxy-3,5,6-trichlorobenzoic acid

X

XF-832—code for calcium propyl arsonate
XPI-29—code for mixture of borax and simazine
XPI-61—code for mixture of borax and fenac
XPI-62—code for mixture of borax, monuron, and 2,3,6-TBA
XPI-63—code for mixture of borax, monuron, and fenac
XPI-69—code for mixture of borax and atrazine

Z

Zytron—trademark for *O*-2,4-dichlorophenyl *O*-methyl isopropylphosphoramidothioate

XUM

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XUM

XUM

XUM